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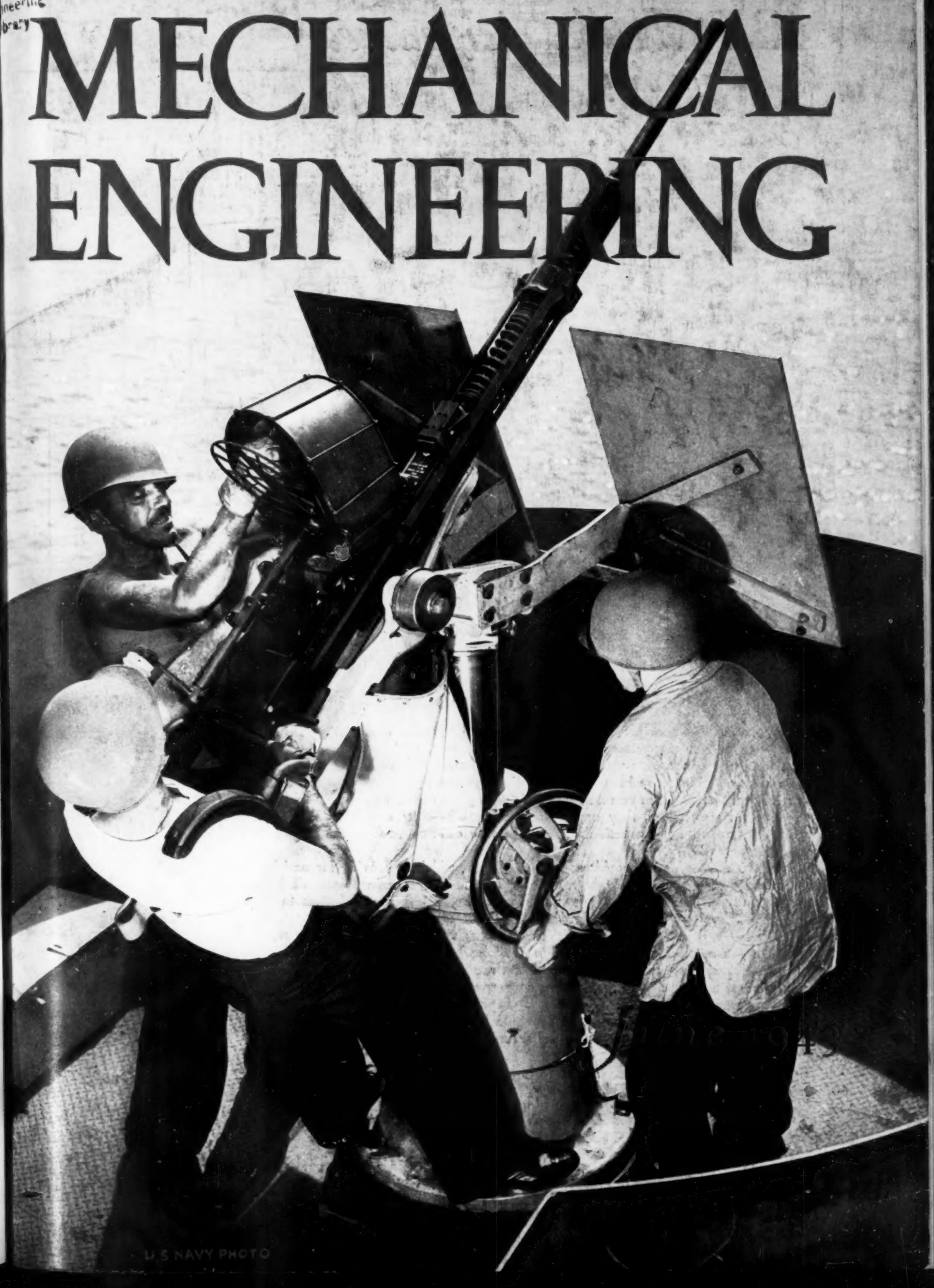
MECHANICAL ENGINEERING



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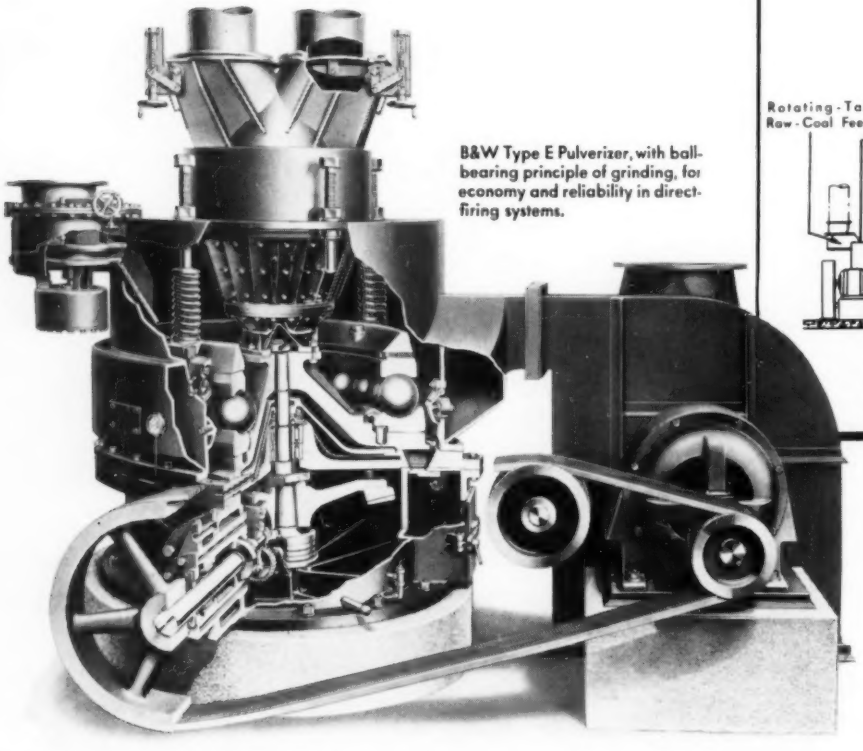

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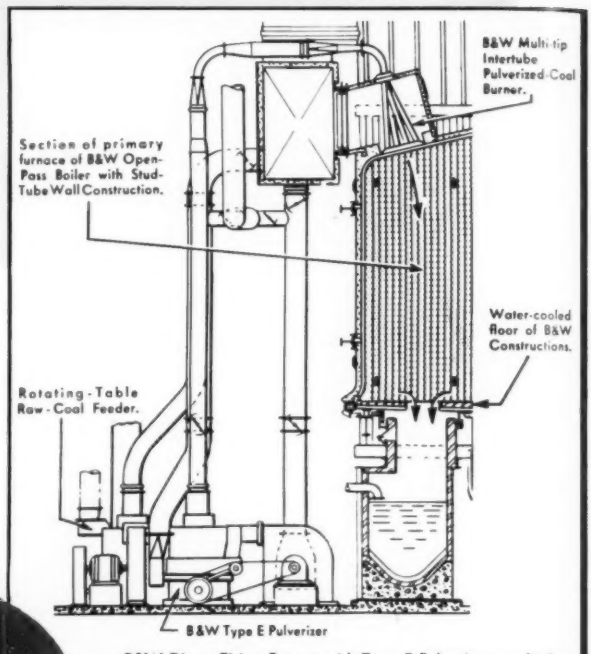
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Following up these suggestions may result in better, more efficient operation of many steam plants.

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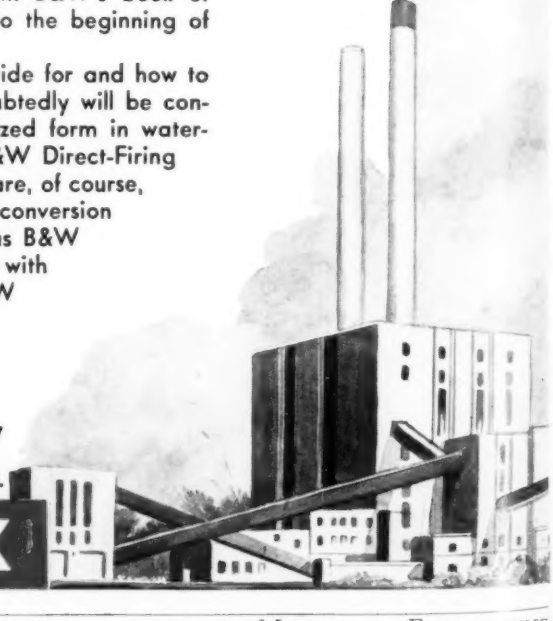

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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 65 . NUMBER 6

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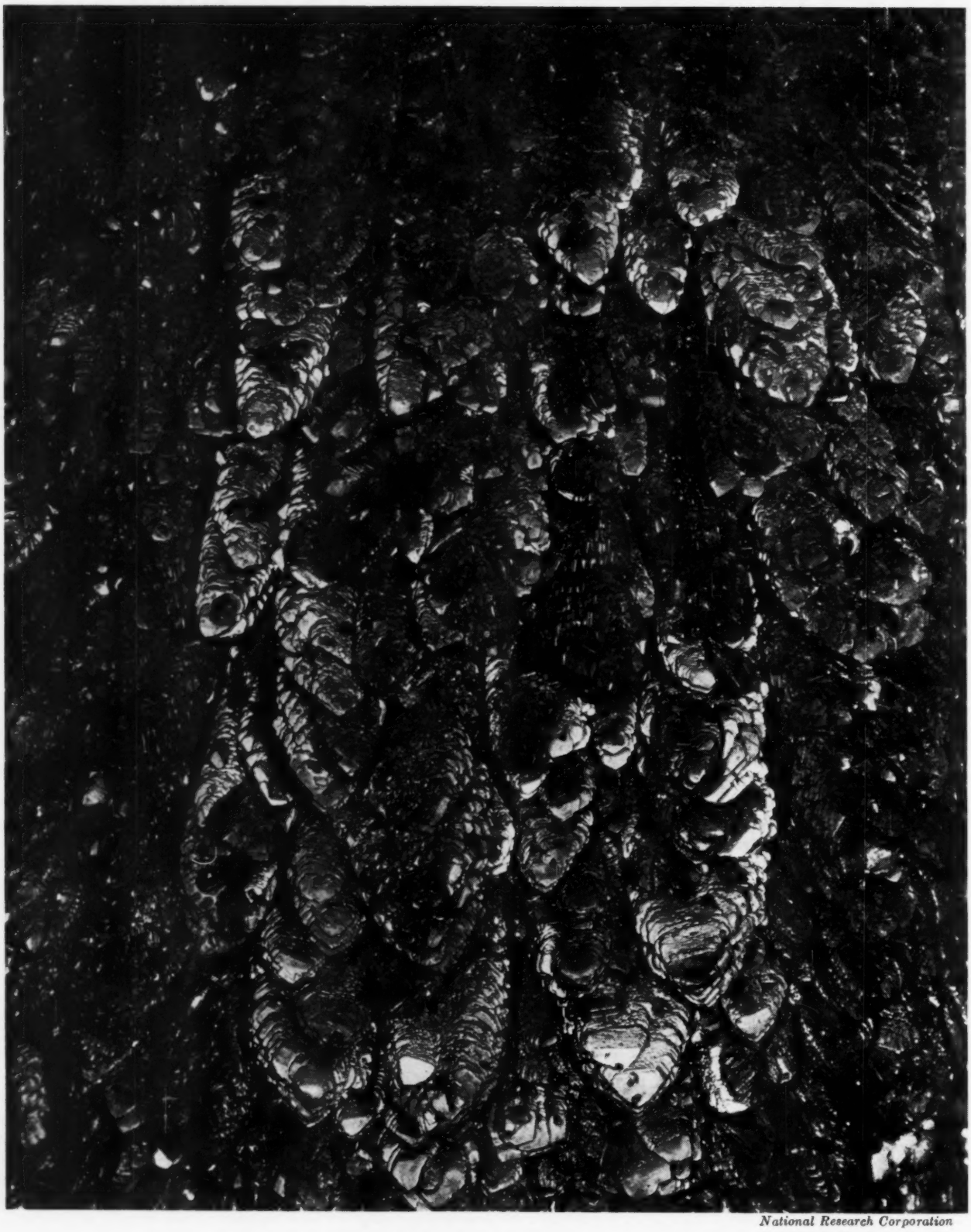
Published monthly by The American Society of Mechanical Engineers. Publication office at 20th and Northampton Streets, Easton, Pa. Editorial and Advertising departments at the headquarters of the Society, 29 West Thirty-Ninth Street, New York, N. Y. Cable address, "Dynamic," New York. Price 75 cents a copy, $6.00 a year; to members and affiliates, 50 cents a copy, $4.00 a year. Postage outside of the United States of America, $1.50 additional. Changes of address must be received at Society headquarters two weeks before they are to be effective on the mailing list. Please send old as well as new address. . . . By-Law: The Society shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B13, Par. 4). . . . Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879. . . . Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921. . . . Copyrighted, 1943, by The American Society of Mechanical Engineers. Member of the Audit Bureau of Circulations. Reprints from this publication may be made on condition that full credit be given MECHANICAL ENGINEERING and the author, and that date of publication be stated.



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(Produced by the thermal reduction of dolomite under a pressure of one hundred thousandth of an atmosphere.)

VOLUME 65
No. 6

MECHANICAL ENGINEERING

JUNE
1943

GEORGE A. STETSON, *Editor*

Managements' Opportunity

MR. HAROLD VINTON COES, president of The American Society of Mechanical Engineers, is doing the nation and the Society a very considerable service by continually emphasizing, in his speeches and presidential letters, the importance of management in the world of today and tomorrow.

Any long-range view of the confusion and upheaval through which we have been passing must include as a major factor the sharp impact of science and technology on our way of living and our relationships with the rest of the world. Learning to live in an industrial society involves evolutionary and revolutionary changes. Those changes cannot be assimilated in a single generation even in countries where they are widespread and rapid. Their influence, because of expanded communication and transportation facilities, extends wherever civilized nations exist or conduct business. That they result in startling changes of economic, social, and political patterns is inevitable.

The conflicting theories of government which have disturbed the world since before the first world war, the trials of democracies in adapting themselves to these new patterns and in conflict with extreme swings toward state control require time for adjustment. That war, world-wide in its effects, is an inevitable consequence is easy to understand.

Unfortunately, wisdom and experience have not been sufficient to avoid war. Unless wisdom does grow through education and understanding and unless experience is widely studied and its lessons turned to profit, we are likely to conclude that the potential benefits of industrialization, greater knowledge of science, and improved use of technology—the closer contacts that are the result of more rapid travel and communication—are heavily outweighed by the hazards and disadvantages which are some of the distinguishing characteristics of the modern era.

Even though a balance of military power were to restore peace to the nations and races of the world, there would still remain the internal forces let loose by changing conditions to be reckoned with. It is this fact which makes Mr. Coes' insistence on the problems of management significant. Time and again he has pointed out the importance of factors which are associated with the non-technological side of industrial life—which have to do not with machines and tools and processes but with the men who operate them.

We are seeing today how potent is mechanized warfare; but we are also witnessing how futile it may become, except for purposes of utter destruction, if it enslaves and degrades men. In our time the problem of mechanization has become acute. History records the conflicts of pastoral with agricultural ways of life. It teaches us what happened when commerce and imperialism upset the way of life of home-abiding folk. We are far enough removed in time from the industrial revolution to understand how the rise of the factory system, multiplying production manyfold, marred its brilliant achievements with plague spots of squalor and the exploitation of the weak, including thousands of the children who should have been the ones to benefit by the emancipation from toil and ignorance that the machine can bring if wisely used.

Extensive as our development of machine production has been, the fact that the changed conditions it introduces bring new and perplexing problems finds us today with vast numbers of our citizens struggling against what appears to be the increase of insecurity and hardship in the midst of potential plenty. The wisest men, even if their views were to prevail against those who are selfish and blind, have no sure remedy that can bring instant relief. But each man, working with what insight and unselfish devotion to the cause of peace and the advance of liberal institutions he may exercise, can have some influence in the small sector of his own environment. With the passage of time, the accumulation of the fruits of industrial progress under conditions of liberty for all and exploitation of none and the benefits that come from education of all, lead us to hope that another generation will see us better adjusted to the way of life that industrial civilization imposes.

In this task of adjustment engineers who are in positions of responsibility in the management of industrial enterprises can exercise tremendous influence. To their knowledge of the technological principles of production they must add an enlightening knowledge of human relationships, a much more perplexing subject. The system must be made to work, or it will overcome us. In placing the challenge of management squarely before engineers, Mr. Coes is directing attention to one of the most important phases of our future progress. The pride that engineers may justly feel in the stand he is taking must be converted into a zeal to help in winning the peace by doing their part, whatever it may be, in intelligent progressive management.

A.S.M.E. Preparedness Record

IN his address at the dinner meeting of The American Society of Mechanical Engineers at Davenport, Iowa, during the 1943 Spring Meeting, published in this issue, James L. Walsh brought together a few bare facts about the long and honorable history of the Society throughout the decades between world wars one and two in connection with national defense. Although many A.S.M.E. members participated in the events

Colonel Walsh recalled, a majority will have forgotten many of them. Brought together they make an impressive record of the assistance the Society and its members gave to the training for M-day in which many Ordnance reserve officers and engineers of industrial plants participated.

Although the detail of preparedness training was principally confined to groups of reserve officers, the programs of Society meetings afforded opportunities for all members to be reminded of the fact that upon the manufacturers and engineers of the nation would fall the heavy burden of production and conversion from peacetime to wartime conditions. Undoubtedly, the close relationship established between the Ordnance Department and engineers and manufacturers during the twenties and thirties was of enormous practical advantage when the time came to enlarge the military services and call for conversion and all-out production.

Practical Co-Operation

A BRIEF article in the *War Production News* for the New England States, published by the War Production Board, tells about the War Production and Engineering Council of Northern Connecticut, organized by 23 engineering and allied groups for the purpose of providing an advisory and consulting service to all war manufacturers of that area. It is gratifying to find The American Society of Mechanical Engineers mentioned as one of the co-operating organizations in this patriotic and public-spirited endeavor.

According to the announcement, to which the attention of MECHANICAL ENGINEERING has been called by Harry E. Harris, Fellow A.S.M.E., chief, engineering department, Hartford District Office of the War Production Board, the advisory and consulting service "represents a broad cross section of experienced technical and engineering talent versed in munitions-production methods, metallurgy, machine design, tool design, chemistry, electroplating, gaging and inspection methods, etc. The pooling of these resources, into one group, as has been done in Northern Connecticut," the announcement continues, "affords a diversification of knowledge seldom found in a single organization of this type. The practical experience and technical information of these engineers and production men can be applied whenever the need arises." To this testimony Mr. Harris adds his personal comment that "this service is being used not only by manufacturers but also by the Armed Services, and a very real engineering service is being performed by this group."

Regardless of what national organizations of engineers, scientists, and technicians may undertake to do in the public welfare, nothing can supplant local initiative and the co-operative efforts of men belonging to an individual community. The engineers of Northern Connecticut are adhering to the code of engineers everywhere, never better expressed than by Rudyard Kipling in the words, "simple service simply given." Great national emergencies call forth the best that everyone can give, and in facing common dangers and common objectives, men learn how effective co-operation can really be.

The years that lie ahead will afford many opportunities for co-operation among engineers in the problems of returning peacetime conditions. Groups of engineers like the one in Northern Connecticut will find the experience of wartime co-operation for the common welfare a source of great satisfaction and a very real benefit to themselves and to their communities.

Dwindling Isolation

FULL-PAGE advertisements in the newspapers of the projected series of seadromes—steel landing fields in midocean—to be placed 800 miles apart between this country and Europe have been received with mixed feelings. Recent developments—and accomplishments—in aviation and engineering have convinced many persons of the practicability of the proposal. Because thousands of persons, including President Roosevelt and Mr. Churchill, have made Atlantic crossings by air without seadromes is no reason for saying that seadromes may not be desirable or worth while. Stops by the way for refueling may easily prove to be economical if cargo and passenger loading can be increased because the fuel load is decreased. Other factors of aerial transportation are also obviously involved and must be weighed and assessed by the experts. With the war foremost in our minds today the military advantages and disadvantages come to mind; like the English Channel, the Atlantic becomes year by year less of a protection. Isolation is dwindling.

If those who are accustomed to look at the globe from the plane of the equator will shift their point of view to the region above the north pole they will discover what Stefansson and others have been calling to our attention for years, that distances over the top of the world from continent to continent are not great and involve flying largely over land. Unpractical as land and sea routes over the polar regions are, air routes do not have the same disadvantages and hazards. They present practical transportation channels and they must be considered in times of war as opening up what have heretofore been frontiers free from the danger of invasion. Here again is plain evidence that our isolation is dwindling to the point of disappearance.

It is well to face the fact of what seadromes and polar air routes may mean to us in the future, in peacetimes and in wartimes. That they can be of great value in communication and commerce with other nations in Europe and Asia is apparent. It is not likely that we can close the polar routes even if we should wish to do so. We can develop them to our advantage, however, and keep alert as to the risks they present. We must face the fact that our isolation is disappearing and conduct our internal and foreign affairs intelligently with this fact in mind.

Science knows no frontiers. Its attack on geographical boundaries is rapidly resulting in their elimination. We must live with the airplane and the changes it is bringing into our lives. It seems incredible that minds that can develop the means for breaking down barriers cannot also, through tolerance, education, and devotion to the best interests of mankind, break up the forces that disturb the peace of the world.

Development of BROACH RIFLING *at* ROCK ISLAND ARSENAL

By WILLIAM BAUMBECK

CHIEF SUPERINTENDENT OF PRODUCTION

IN 1918 an experienced operator was capable of rifling about six caliber 0.30 rifle barrels in 1 hr by the conventional rifling method. This was considered quite productive since such a rate indicated that he was attending two or more machines. Today, by means of a modern broaching machine and special broaches, an operator is able to rifle 40 similar barrels in the same length of time.

Rock Island Arsenal takes considerable pride in its contribution to the development which has resulted in the economies and advantages obvious in the foregoing statement, and in the fact that these advantages are being utilized in a large number of plants manufacturing small-arms weapons.

Since the manufacture of machine-gun and rifle barrels requires the use of certain rather specialized equipment, it would probably be well to list the principal machining operation involved with a brief description of the particular step with which this paper is concerned.

THIRTY-FIVE OPERATIONS REQUIRED TO PRODUCE A MACHINE-GUN BARREL

Since a total of thirty-five operations are involved in the manufacture of a machine-gun barrel, the following steps are by no means complete but indicate the more important ones in the fabrication of a barrel: (1) Cut to length and center; (2) rough-turn; (3) drill; (4) first ream; (5) finish-turn; (6) finish-ream; (7) rifle; (8) chamber.

Without doubt most readers are aware that the stability of a bullet in flight is dependent upon the rotation imparted to it during its passage through the bore. This initial rotation is effected by means of the rifling which, in the case of caliber 0.30 barrels, usually consists of four grooves approximately 0.004 in. deep and 0.171 in. wide, machined in the bore to form a spiral making one turn in ten inches. This discussion is intended to describe an improved process for the machining of these grooves.

USUAL RIFLING METHOD

For years, the accepted manner of producing such grooves has been by means of either sine-bar- or lead-screw-type rifling machines, Fig. 1. These machines are similar, inasmuch as they both impart to the rifling tool a reciprocating and rotary motion. The tool itself, Fig. 2, is assembled in a head, fixed to the end of a hollow shaft through which cutting oil is pumped to the work. The distinctive feature of this process is that the single cutting edge of the tool is presented to only one groove at a time and removes but a few thousandths in each pass. The barrel being machined is indexed 90 deg after each stroke and the tool retracted in the head with each return. With every complete revolution of the barrel, the tool is advanced slightly for the next series of cuts. In spite of the fact that all the operations mentioned are automatic, approximately 20 min are required to complete the rifling in a single barrel.

Broach rifling of gun barrels is not new. Barrels of larger caliber have been successfully rifled by this method for some time. Technically, it might be contended that the original hook tool is no more than an adjustable single-toothed broach. However, forgetting such technicalities, it is reasonably certain that prior to 1940 no practical method had been devised for broaching of military rifle and machine-gun barrels. For a number of years the process had been considered by Springfield Armory and by various broach manufacturers. Although satisfactory results were obtained with the rifling of pistols and revolvers, the efforts in connection with the longer barrels were eventually dropped as impracticable.

In 1936 Rock Island Arsenal was directed to undertake certain modification work which entailed the manufacture of caliber 0.30 machine-gun barrels. The rifling operation was set up on Pratt & Whitney single-spindle rifling machines. At that time several experiments, conducted with a hand-operated broach and short barrel sections, indicated that further development would be worth while.

The following year an attempt was made to interest a commercial manufacturer of broaching equipment in the development and design of suitable tools and fixtures, but for one reason or another the work was declined after a preliminary study.

It was not until 1938 that the subject of broaching was again considered, and since manufacturing operations in the Ordnance Department were then on a comparatively small scale, considerable salesmanship was required to obtain the necessary funds.

SUCCESSFUL BROACH DEVELOPED

The Illinois Tool Works, Chicago, was approached as to its willingness to co-operate in the development of the experimental broach used at the Arsenal the previous year, and to design the necessary fixtures and equipment to utilize such a tool. W. C. Bohle, chief engineer of the company, was enthusiastic over the suggestion and the possibilities it implied. There then followed a series of trials and discussions between Mr. Bohle and the author, eventually resulting in the development of a tool which not only generated its own spiral but also produced the high finish and accuracy demanded in a rifle barrel. The immediate outcome of these results was an order placed with the Illinois Tool Works for a special fixture and a set of broaches.

Although the first equipment was still more or less of an experiment, it was designed along production lines and consisted principally of the following (see Figs. 3 and 4): (1) roughing broach; (2) finishing broach; (3) a freely rotating puller; (4) quick-release clamps to retain the barrel; (5) suitable attachments to provide cutting fluid under pressure to and through the bore.

The design used in the manufacture of the two broaches mentioned has remained essentially unchanged on subsequent manufacture. The principle of operation is shown in Fig. 5, and method of lubrication in Fig. 6.

WORKING DETAILS OF RIFLING BROACHES

These broaches are approximately 52 in. in length and are similar in all respects except the tooth diameters. There are eleven teeth on each, those on the roughing broach ranging from 0.3024 to 0.3068 in. diam, and those on the finishing

Contributed by the Production Engineering and Aviation Divisions and presented at the Spring Meeting, Davenport, Iowa, April 26–28, 1943, of The American Society of Mechanical Engineers.

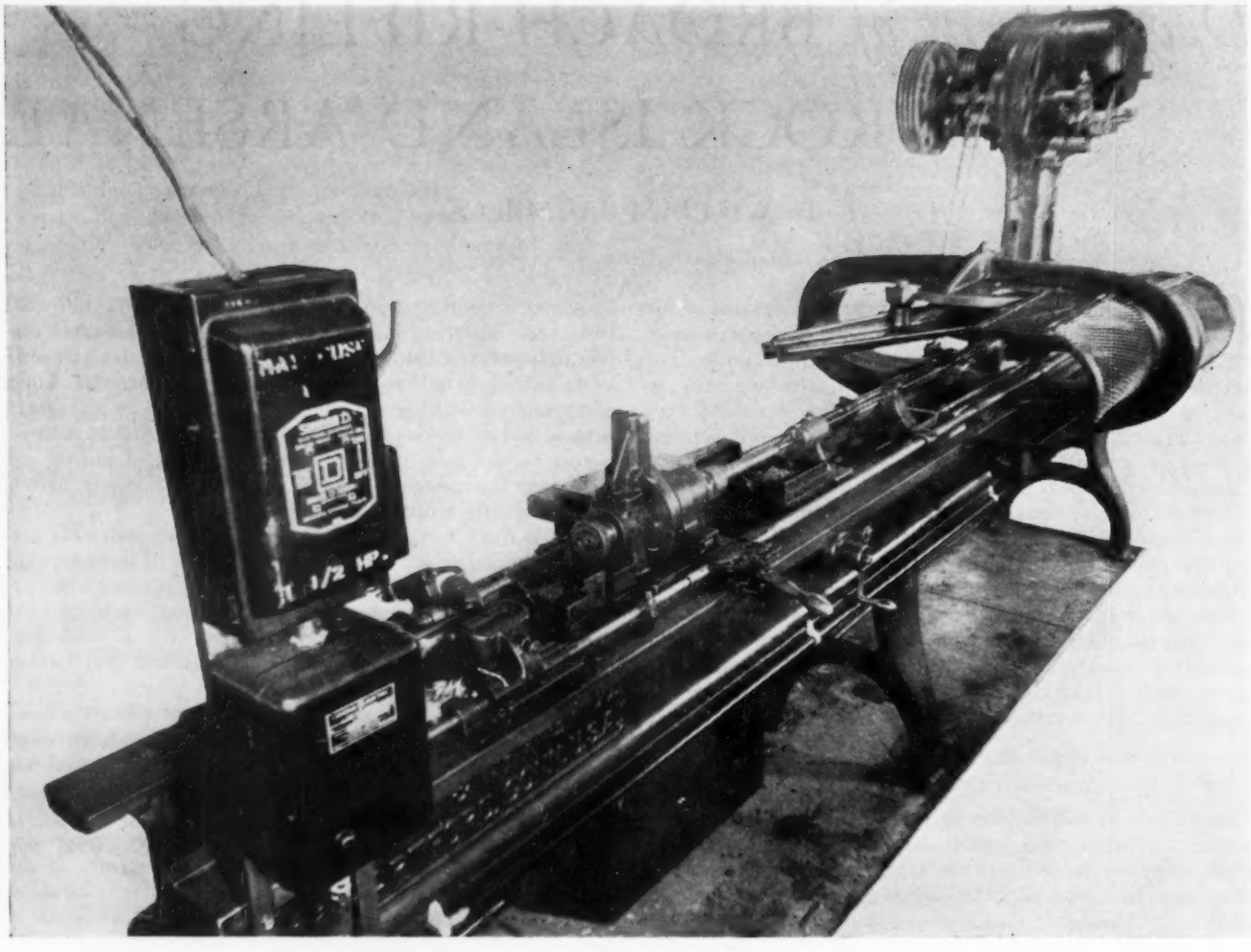


FIG. 1 PRATT & WHITNEY SINGLE-SPINDLE SINE-BAR RIFLING MACHINE

FIG. 2 CUTAWAY VIEW OF ASSEMBLED RIFLING HEAD FOR CALIBER 0.30 BARREL

broach from 0.3068 to 0.3093 in. There are several interesting features regarding these teeth; in order to facilitate the passage of the cutting fluid and to provide clearance for cuttings, each tooth consists of two sections, front and rear. Each section has two opposed cutting edges and is offset in such a manner that the first section cuts one pair of grooves while the second forms the other pair.

The first nine teeth of each broach are equipped with chip breakers which are no more than small longitudinal grooves ground along the body of each tooth to avoid the formation of excessively large cuttings. The location and spacing of these grooves are staggered in such a manner that each tooth removes the ridges left by the preceding one. The last two teeth are without this feature and present unbroken cutting edges.

The novelty of the broaches and the feature which distinguishes them from other types developed later for similar purposes is that they produce their own lead. This is accomplished by means of the helical angle to which the sides of all teeth are ground.

It will be noted that the first broaches were procured as a set, one roughing and one finishing. This practice was discontinued shortly after the first purchases, when it was shown that finishing broaches, worn and sharpened to minimum dimensions, could be reground and used as roughers. The economy of such salvage is obvious.

Upon receipt of this equipment, the fixture was attached to an old LaPointe No. 3 broaching machine. Fifty barrels were rifled and subjected to a very close inspection which indicated they were generally satisfactory. As might reasonably be anticipated in connection with any very radical innovation, several objections to this process and its practicability were voiced. However, firing tests conducted at this Arsenal and at Springfield Armory with these barrels were promising and a very satisfactory and complimentary report was returned to Rock Island Arsenal.

As a result of this work, the Arsenal was directed to broach-rifle one thousand barrels for use in additional firing tests to be conducted at Springfield Armory, in order to determine conclusively the relative merits of the process. The findings and conclusions arrived at in this more comprehensive test are indicated in the following quotation from a letter of the Chief of Ordnance to Springfield Armory:

"The results obtained in the accuracy and endurance tests of the broached machine-gun barrels appear quite promising. In view of the indicated advantages of broaching over the present method of rifling, it is important that definite information

be established at an early date to show whether broaching could not be used to advantage with the prospective enlarged machine-gun production. The tooling for these plants will be vitally affected. When the tests have been completed, the conclusions and recommendations of Springfield Armory should be reported by teletype as to whether any or all of the new plants should be tooled to produce broached machine-gun barrels."

BROACH RIFLING APPROVED FOR STEPPED-UP PRODUCTION

In November, 1940, Rock Island Arsenal was advised that the broach-rifling method was acceptable for use in current production. The Arsenal was also requested to make the details of this process available to all machine-gun manufacturers desiring the information. Twelve sets of broaches and a special broaching machine were immediately ordered from the Illinois Tool Works. Delivery was made on these items in April, 1941 (see Fig. 7).

When this equipment was first placed in operation certain difficulties were encountered in broach maintenance and in obtaining a satisfactory finish in the barrels. It was soon evident that these difficulties were interrelated and were both due to a single cause, that is, the original broach finish.

These particular troubles were eventually eliminated by the adoption of minor changes in rake and clearance angles and by more rigid inspection of the broaches. As a further precaution, a gage was installed on the machine to indicate the tension on the broach during the stroke. Readings from this gage are in themselves a good index to the condition of the tool since the force necessary to draw the broach increases rapidly as the cutting edges become dull.

It has since been determined that maintenance of the proper finish on the cutting edges and associated surfaces is the most important single factor affecting rifling operations. For consistently successful results the greatest care and attention must be given these points at all times. To facilitate in this there has been procured from the Illinois Tool Works an inspection fixture, Fig. 8, and a broach grinder, Fig. 9.

An early and not unsound argument which had been advanced against the use of broach rifling was the possibility of losing an expensive tool through carelessness or breakage due to faulty barrel stock. Such a loss would naturally be much more serious than the similar loss of relatively inexpensive hook tools. Little trouble of this nature has been experienced. Even prior to the application of broach rifling certain machinability standards for barrel steel were adopted by the Arsenal. These requirements were in addition to exacting physical and chemical specifications. However, one of the most important safeguards against poor material reaching the broach is the series of inspections to which each barrel blank is subjected in the course of operations preceding rifling.

A further precaution which has assisted materially in reducing broach maintenance and casualties is the practice of grouping barrels according to bore diameter. There is a permissible tolerance of 0.002 on the 0.300 bore diameter of the barrel. This allowable variation fits conveniently into the broaching method, since it is obvious that, with repeated sharpenings, the diameter of the broach will be reduced.

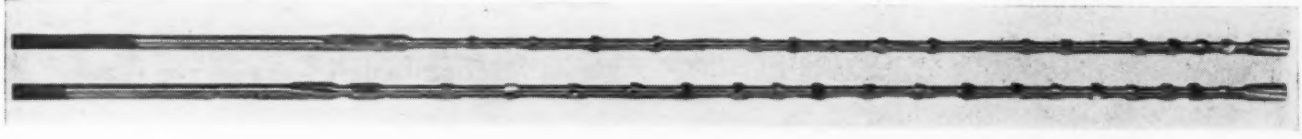


FIG. 3 ROUGHING AND FINISHING BROACHES FOR GUN BARREL OF BROWNING MACHINE GUN, CALIBER 0.30

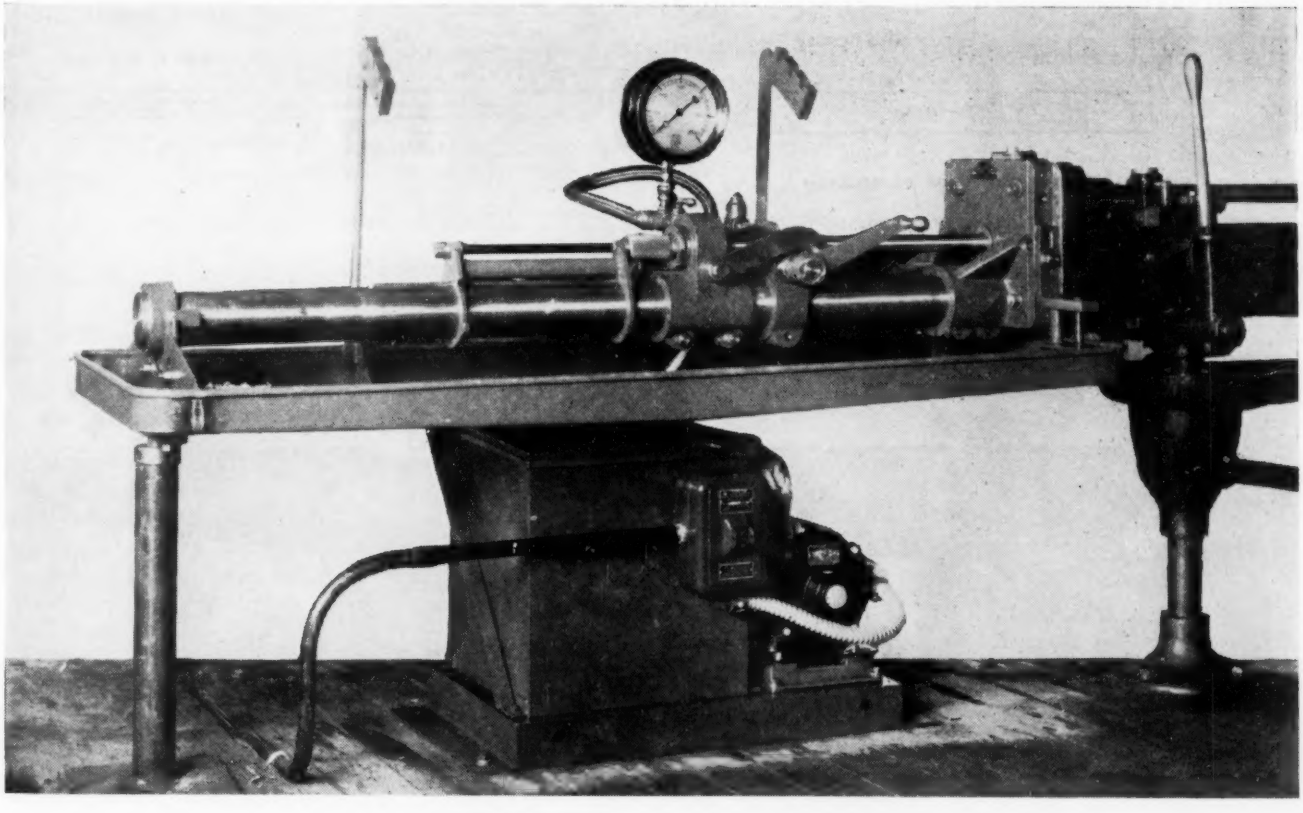


FIG. 4 BROACHING FIXTURE FOR GUN BARREL

After the final reaming operation, all barrels are normally given an inspection check to determine that the bore is within tolerance. With the Sheffield air gage now in use, it is a relatively simple matter to segregate the barrels into several groups according to bore diameters. Thus it is possible to broach all maximum barrels with a new broach, while barrels with minimum bores are set aside to be rifled with a tool reduced in size through sharpening.

PRACTICAL RESULTS OBTAINED FROM USE OF METHOD

In the months which have passed since the first production barrels were rifled by the broach method, the numerous variables affecting the process have gradually been either eliminated or controlled to such an extent that the method has entirely replaced the traditional hook tool in manufacturing operations at Rock Island Arsenal.

Results have actually exceeded expectations; when the process was under development, the natural goal was to equal the quality of a barrel rifled in the ordinary manner. This is accomplished in everyday production, and it has since been demonstrated that, with only ordinary care and selection, it is possible to exceed in uniformity the best barrels produced by the old method. This fact came to light recently when this Arsenal was requested to furnish special barrels to Frankford Arsenal for the purpose of testing ammunition; the tests requiring barrels manufactured with only $^1/_4$ of the tolerances normally allowed.

It has been found that, due to the nature of the broaching operation and the type of labor involved, female operators are generally more adaptable than male. This fact is most fortunate in view of the present labor situation.

TABLE 1 COMPARISON OF BROACH RIFLING AND CONVENTIONAL RIFLING, BASED ON RATE OF 40 BARRELS PER HR

	Broach method	Conventional method
Machines required	1	10
Unit machine cost	$7500	$11225
Total installation	7500	112250
Floor space, sq ft	40	700
Operators required	1	5
Tool cost per barrel	$0.1050	$0.0816
Total rifling cost per barrel	0.1334	0.2332

Because of the schedules demanded on the average plant today, production has rightfully become the first consideration. Fortunately, however, there is still a wholesome interest shown in the figures and costs behind such production. Many of the circumstances affecting the rifling operation at Rock Island Arsenal have changed since the adoption of the new method, making it somewhat difficult to set up an accurate comparison of the two processes; and, while Table 1 is not complete in all respects, it is probably as brief a summary as it is possible to make.

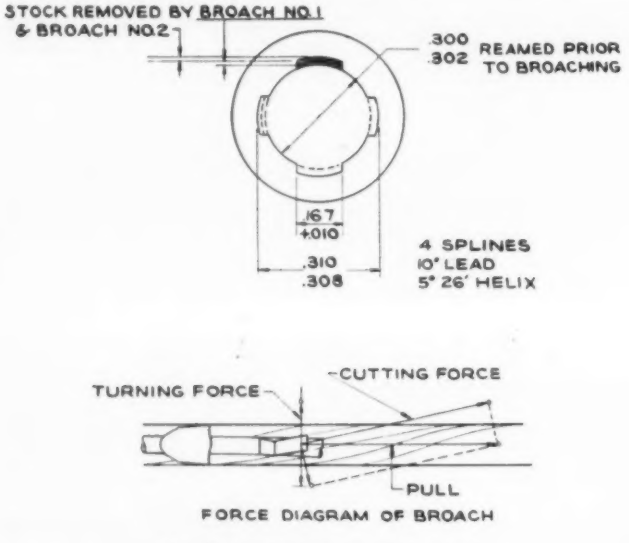


FIG. 5 PRINCIPLE OF OPERATION

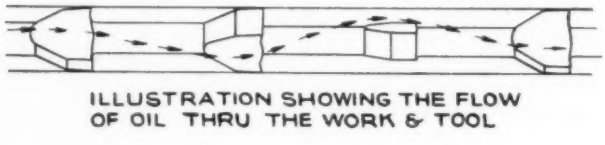


ILLUSTRATION SHOWING THE FLOW OF OIL THRU THE WORK & TOOL

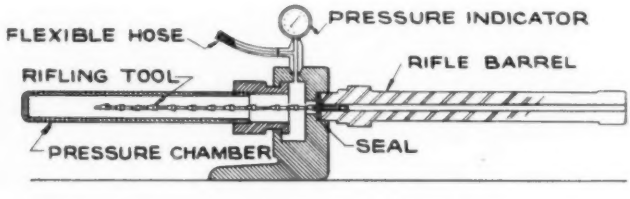


FIG. 6 METHOD OF LUBRICATION

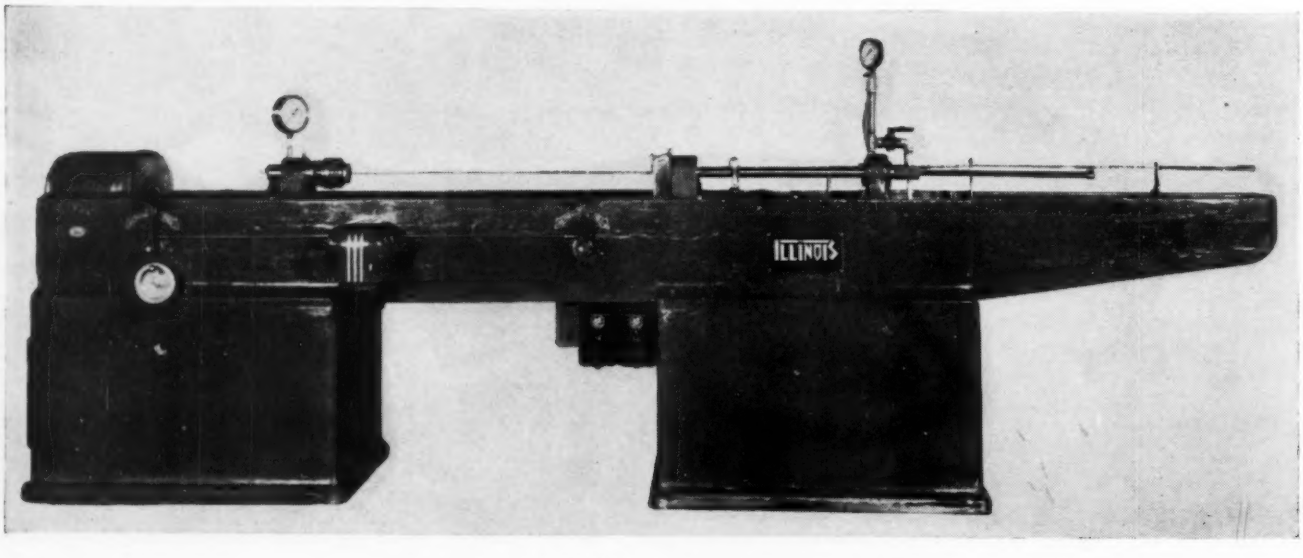


FIG. 7 CALIBER 0.30 RIFLE-BROACHING MACHINE

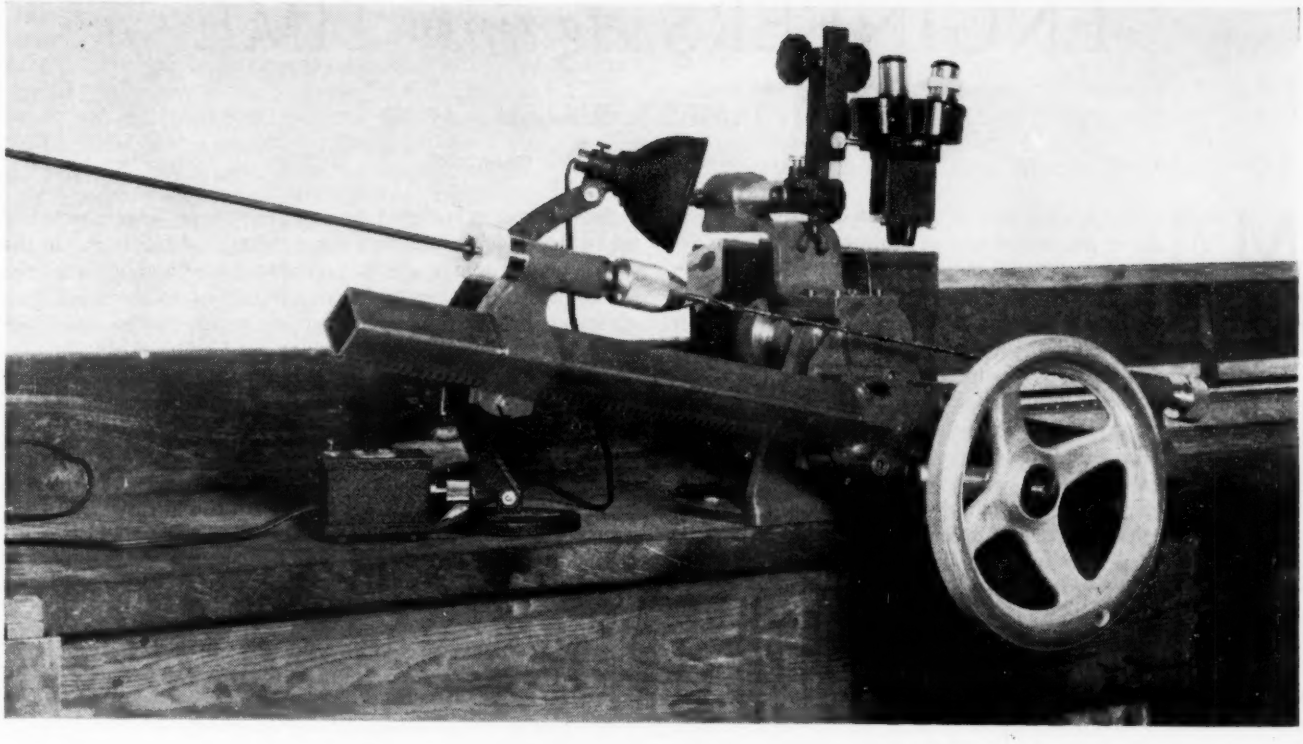


FIG. 8 INSPECTION FIXTURE FOR GUN-BARREL BROACH, CALIBER 0.30

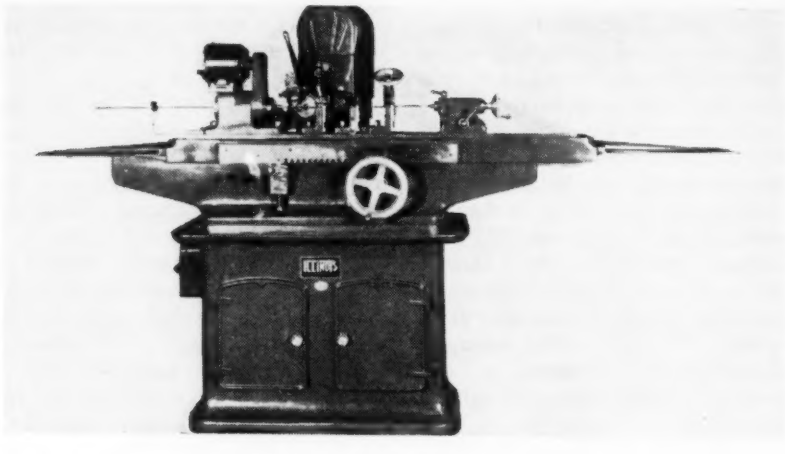


FIG. 9 RIFLING-BROACH GRINDER

In explanation of Table 1, it should be pointed out that the number of machines required is based upon average rates. In the case of the broach, the rate has been constantly improving. At one time, 240 barrels in an 8-hr day were considered better than average. At present, the figure stands at 320, and there are indications that it may be improved still further, as one operator recently processed 425 barrels in 8 hours. The other points in the comparison are based upon the best conditions obtained with both methods. The figures representing the conventional method reflect a number of improvements which were adopted after the broaching process was introduced, many of which were the indirect results of studies made in connection with the broaching method.

The number of conventional rifling machines listed as equivalent to the single broaching machine is somewhat arbitrary, since it represents modern two-spindle machines, with which this Arsenal has had no experience. Actually, the broaching machine has replaced twenty single-spindle machines of the type formerly used.

The figures representing tool cost take into consideration the factors given in Table 2.

TABLE 2 FACTORS OF TOOL COST

	Broach	Conventional
Original tool cost, including stores expense (7 per cent)	$173.34	$ 4.23
Average tool life, no. of barrels	2000	250
Cost of rifling head, including chrome plating	....	$70.00
Life of head, no. of barrels	....	10000
Cost to convert broach	$ 8.78	....
Tool maintenance	0.014	0.0577

The total cost per barrel was calculated to include the factors given in Table 3.

TABLE 3 ITEMS INCLUDED IN TOTAL COST PER BARREL

	Broach	Conventional
Tool cost per barrel	$0.1050	$0.0816
Labor per barrel (including overhead)	0.0284	0.1516

ACKNOWLEDGMENT

The author wishes to acknowledge the co-operation and assistance which the Arsenal received from the personnel of the Illinois Tool Works in this development.

ENGINEERS *Against* TIME

By JAMES L. WALSH

CHAIRMAN, A.S.M.E. WAR PRODUCTION COMMITTEE

MILLIONS of human lives in the United States alone are at stake in the crucial race of engineers against time—and the race is by no means won, as yet. Engineers are realistic by disposition, education, and professional experience; they labor under no illusions that novel designs of secret weapons or overwhelming production of standard munitions will win the war. Nor will superbly efficient railroad transportation, miracles of building and operating cargo vessels, bond-buying campaigns, victory gardens, or propaganda pamphlets. These are all necessary, but, in the final analysis, this is a fighters' war—a soldiers', sailors', and aviators' war. They alone do the fighting—and most of the dying.

"A warning that one out of every ten Navy men might be killed or wounded was made public by the House Sub-Committee on Naval Appropriations," according to an Associated Press dispatch published by the *New York Times* on Thursday, March 4, 1943, in connection with the proposal by Secretary of the Navy Knox for a Navy totaling 2,250,000 men by July, 1944. According to the same dispatch, Secretary Knox stated that on Feb. 8, 1943, Navy casualties totaled 19,022, but Rear Admiral Randall Jacobs, Chief of the Navy Bureau of Personnel, explained that "less than 10 per cent of the Navy had been involved in fighting," and Secretary Knox added, "we have just begun to fight." If the same "one out of every ten" casualty rate holds for the expected total of eleven million men in our armed forces by the end of this year, the engineers' race against time is, in effect and in fact, a race to save lives.

But deaths in battle are not the only war casualties. The influenza epidemic which followed in the wake of the First World War caused a million deaths—indirectly attributable to the ravages of war. Crowded and unsanitary housing, inadequate heating, insufficient medical and surgical personnel and facilities—all invite a repetition of war-caused epidemics. Malnutrition and pestilence now endemic in combat zones and liberated areas can spread to the United States more quickly than ever before in our history, owing to the very velocity of our extensive and expanding aerial transportation facilities.

So, here in the United States 135,000,000 people, throughout the United Nations a total of 1,500,000,000, and in the 2,500,000 square miles of Axis conquered territory an additional population of 310,000,000 dominated and enslaved human beings await the outcome of the race against time. For, the best hope of a grand aggregate of 1,810,000,000—nearly 90 per cent of the world's population—is not merely victory for the United Nations but *quick* victory to save human lives, perhaps our own.

Time is today the most valuable commodity the world has ever known in all its history. Congress has appropriated hundreds of billions of dollars—but Congress cannot appropriate a single second of time. But, engineers can, in effect, "appropriate" time by devising time-saving designs, processes, production practices, and procedures. Basically, an engineer is not only a person who in peacetime can do for one dollar what others can do for two dollars, but also a person who, in wartime, can do in one hour what others can do in two hours.

A.S.M.E. NATIONAL-DEFENSE PROGRAM MORE THAN 20 YEARS OLD

More than 20 years ago the engineers of America sensed that time was destined to be the critical and controlling factor in national defense. In 1923 The American Society of Mechanical Engineers not only created and actively supported a National Defense Division but gave without cost to the Government free use of its headquarters, conference rooms, and facilities. In the very Council room of this Society was created and perfected the pattern for the Ordnance District system of decentralized procurement, production, and inspection which the present Chief of Ordnance, Major General Levin H. Campbell, Jr., has on many occasions credited with being the foundation stone of satisfactory production of ordnance, not only for the United States Army but for the fighting forces of the United Nations.

For 18 years some 200 Ordnance reserve officers met every Monday evening in the Council room to study blueprints of weapons, to familiarize themselves with the intricacies of government contracts, and to plan surveys of commercial plants in the metropolitan New York area which could be converted promptly for the reduction of ordnance in the event of an emergency.

On April 6, 1924, the first test mobilization of reserve officers and the Advisory Board of the New York Ordnance District, under the leadership of Judge Elbert H. Gary, chairman of the board, United States Steel Corporation, was held. This was the first mobilization of its kind held in this or any other country, and the results obtained were so satisfactory to Colonel Harley B. Ferguson and Major Townsend Whelen, who attended as observers for the Secretary of War, that a similar nation-wide industrial mobilization test was ordered for the following September.

On September 12, 1924, the eighth anniversary of the American victory of the Battle of St. Mihiel, acting upon orders flashed from Washington, the New York Ordnance District temporarily was established on a war basis using an entire vacant floor of the Engineering Societies Building. Complete detailed plans were quickly put into effect whereby suitable office furniture was actually moved into place, necessary new typewriters were physically delivered, complete telephone service with fully functioning private branch exchange was installed by the New York Telephone Co., national and international telegraph communication was established by the Western Union Telegraph Co., and radio communication with the world was installed by the Radio Corporation of America. All of this was completed to the last detail within five hours of the receipt of the mobilization order.

On April 6, 1926, with the financial assistance of The American Society of Mechanical Engineers and the approval of the advisory board of the New York Ordnance District, there was published the famous "Circular 4" of headquarters, New York Ordnance District, which set forth briefly the philosophy of industrial preparedness, a detailed statement of the organization of the New York Ordnance District, and a complete manning table of commissioned personnel. It was even provided that each officer on reporting should bring with him his secretary and that the secretary should bring with her a couple of note books and a plentiful supply of stenographer's pencils. This circular became the "bible" in organizing the other 13 ordnance districts which among them covered the whole area of the United States.

During all this period the New York Ordnance District had the enthusiastic, loyal, and generous support of the late Calvin W. Rice, for many years secretary of The American Society of Mechanical Engineers. It had the benefit of the wise counsel of the members of the Ordnance Advisory Board which included, in addition to Judge Gary, P. E. Crowley, president, New York Central Railroad; J. M. Davis, president,

Presented at the Spring Meeting, Davenport, Iowa, April 26–28, 1943, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

D.L.&W. Railroad; M. Friedsam, president, B. Altman & Co.; General James G. Harbord, chairman, Radio Corporation of America; Dwight W. Morrow, senator from New Jersey; Seward Prosser, chairman, Bankers Trust Company; Guy E. Tripp, chairman, Westinghouse Electric and Manufacturing Co.; William H. Woodin, president, American Car & Foundry Co.; and Owen D. Young, chairman, General Electric Co.

It is worthy of note that the officers of the Regular Army detailed one at a time to work with The American Society of Mechanical Engineers and the reserve officers of the New York Ordnance District included Major Phillip R. Faymonville, now brigadier general and chief of the American Military Mission in Moscow, and Lieutenant Jonathan L. Holman, now brigadier general, chief ordnance officer on the staff of General Douglas MacArthur in Australia—so that possibly the Regular Army officers benefited by their contact with The American Society of Mechanical Engineers and the reserve officers of the New York Ordnance District, and vice versa.

A.S.M.E. WAR PRODUCTION COMMITTEE

Two years before the actual outbreak of the present war for survival, The American Society of Mechanical Engineers had formed a National Defense Committee which since Dec. 7, 1941, has been continued in operation as the War Production Committee. The work of this committee has been commended not only by the Chief of Ordnance of the Army but by the assistant to the Chief of Naval Operations of the Navy. At present its membership consists of the following:

Rear Admiral J. A. Furer, Navy Department, Washington, D. C., representing the U. S. Navy.

Brigadier General T. D. Weaver, Corps of Engineers, Army Service Forces, War Department, Washington, D. C., representing the U. S. Army.

K. H. Condit, dean of engineering, Princeton University, representing the Management Division of The American Society of Mechanical Engineers.

C. F. Dietz, president, Lamson Company, Syracuse, N. Y., representing the Materials Handling Division, A.S.M.E.

Sol Einstein, vice-president, Cincinnati Milling Machine Company, Cincinnati, Ohio, Production Engineering Division, A.S.M.E.

D. S. Ellis, chief mechanical officer, Chesapeake and Ohio Railway Company, Cleveland, Ohio, and W. M. Sheehan, assistant vice-president, General Steel Castings Corporation, Eddystone, Pa., representing the Railroad Division, A.S.M.E.

A. R. Stevenson, Jr., assistant to vice-president, General Electric Co., Schenectady, N. Y., Aviation Division, A.S.M.E.

T. H. Wickenden, assistant manager, research and development, International Nickel Company, Ltd., New York, N. Y., Metals Engineering Division, A.S.M.E.

W. L. Batt, vice-chairman, W.P.B., Washington, D. C.

C. E. Brinley, president, Baldwin Locomotive Works, Philadelphia, Pa.

Harvey N. Davis, director, Office of Production Research and Development, president, Stevens Institute of Technology, Hoboken, N. J.

W. C. Dickerman, president, American Locomotive Company, New York, N. Y.

Gano Dunn, president, J. G. White Engineering Corporation, New York, N. Y.

W. F. Durand, Division of Engineering, N.R.C., Washington, D. C.

W. S. Finlay, Jr., vice-president, J. G. White Engineering Corporation, New York, N. Y.

R. E. Flanders, president, Jones & Lamson Machine Company, Springfield, Vt.

R. M. Gates, president, Air Preheater Corporation, New York.

K. T. Keller, president, Chrysler Corporation, Detroit, Mich.

David Larkin, general manager, Broderick and Bascom Rope Company, St. Louis, Mo.

F. T. Letchfield, special assistant to chairman (Engineering Office), National Defense Research Committee, Washington, D. C.,

T. A. Morgan, president, Sperry Corporation, New York, N. Y.

R. C. Muir, vice-president, charge of engineering, General Electric Company, Schenectady, N. Y.

E. A. Muller, president, King Machine Tool Company, Cincinnati, Ohio

T. E. Murray, Metropolitan Engineering Company, Brooklyn, N. Y.

Brigadier General F. I. Westervelt, associate, Frederic R. Harris, Inc., New York, N. Y.

A. C. Willard, president, University of Illinois, Urbana, Ill.

WE MUST THINK IN TERMS OF TIME

During the past few months we have learned to think of distance in terms of *time*—but with 1,328,000 square miles to reconquer in the southern Pacific area alone, and 119,000,000 people to liberate from Japanese slavery in that same area, engineers must begin to think of weight in terms of time. It is perfectly obvious that our definitely limited amount of railroad transportation can transport more weapons and other munitions of war in less time by reducing not only the weight of the article itself but the weight of its container. By decreasing the turnaround time of our freight cars by two days, we can, in effect, "build" an additional 100,000 freight cars.

Engineers must also begin to think of bulk in terms of time. There is just so much ocean shipping available and bulk is the controlling factor in ocean shipping. If we can reduce the bulk of weapons and other munitions by say 20 per cent, it is also obvious that four ships will then do the work of five. In brief, we have saved one cargo ship out of every five. We have also saved the necessity for one merchant-marine crew for each cargo ship thus saved. Furthermore, if we can reduce the number of ships required to carry a given lot of equipment by 20 per cent we can reduce the number of armed escort vessels and still retain the same degree of safety. On top of that we save the trained naval crews for those escort vessels and the training facilities for these naval crews.

These goals are by no means impossible. They can be reached and in a large measure they already have been. In several instances they have been vastly exceeded. For instance, in shipping rations to our own troops with the combat forces of the United Nations and the liberated peoples of reconquered territory, thanks to the recently developed dehydration process, we do not save a mere 20 per cent but an actual 80 per cent of the shipping previously required to carry exactly the same amount of nourishment.

As a matter of fact, in the case of beef after dehydration, it is being compressed so that we save 90 per cent of the shipping space required a year ago. As regards beef, we are in effect saving nine ships out of ten; we are saving nine merchant-marine crews out of ten; we are saving a proportionate 90 percent of the escort vessels needed on convoys; we are saving 90 per cent of the trained naval crews for those escort vessels, and that correspondingly reduces the load on the naval training stations.

Furthermore, when nearing Africa every convoy must have a proper air "umbrella" and the number of planes in that "umbrella" is roughly proportionate to the number of cargo vessels plus the number of escort vessels. So we not only save in number of planes, in number of trained air personnel, but we save needless expenditure of high-octane gasoline and that reverts back to requiring fewer tankers to transport it from the western continents.

Engineers cannot win the war—only fighters can do that—but engineers can help our fighters increase the tempo of our offensive operations, reduce the number of casualties, hasten the end of the war, and *save human lives*. That, in brief, is the prize in the engineers' race against time.

MANAGEMENT'S CONTRIBUTION *to the* WAR-PRODUCTION EFFORT

By HAROLD V. COES

PRESIDENT OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

DONALD W. DOUGLAS recently stated the broad management problem in the airplane-manufacturing industry as follows:

"When a layman looks at a Flying Fortress he sees a sleek streamlined machine. When an aircraft builder looks at the same machine he sees 110,000 separate parts, a goodly number of which were not made in the factory which assembled the plane but were flown to the assembly line from some 6000 plants scattered over the nation. This type of mass engineering has been brought about, in large measure, by the quiet spade work of committees of engineers who have disseminated standards of types, qualities, and tolerances of raw materials to weld into one giant warplane industry thousands of scattered factories that once made radio sets, baby carriages, washing machines, hairpins, and other peacetime goods."

Think of the problems of management, in providing new manufacturing, assembly, and test facilities; building up the administrative and supervisory organization, providing factory workers of both sexes, planning, scheduling, co ordinating, and procuring materials, tools, and supplies. That is what was involved in Mr. Douglas' statement.

To request that 100,000 military planes be produced in a year does not produce them, as we well know; that is just a requisition for production. These demands set in motion, however, such gigantic engineering projects as the Chrysler Corporation's new plane-engine factory in Chicago, one of the largest plants in the world. This, in itself, is an engineering feat which in many respects rivals our Boulder Dam hydroelectric project.

You can readily appreciate the mass of engineering calculations, sketches, drawings, and specifications required, the procurement problems in securing materials and men before these facilities could even be constructed.

Think of the improvisations that were made to save critical materials, to replace unavailable production facilities, and to overcome unforeseen contingencies, such as developing single-purpose plane-engine drilling machines from portable bench-type drills, or changing structural designs from steel to timber, and the like.

Think of the stupendous mass of details that had to be meticulously fitted together, and you then have some comprehension of the management skill required for co-ordination and administration. How has it worked out? Well, as Alfred Smith would say, "Let us look at the record."

MIRACLES OF PRODUCTION

In 1937, there were 10 shipyards with 46 ways, able to accommodate ships 400 feet long, or over.

In 1943 there are 60 such yards with more than 300 ways. Six times as many yards with $6\frac{1}{2}$ times as many ways, with a capacity of 20,000,000 deadweight tons of ship construction. The work was distributed to the people who knew how (i.e., management) in both old and new yards.

In 1942, a total of 750 ships were constructed, of which 570 were of the "Liberty" type. The average time of construction was $52\frac{1}{2}$ days from the time the keel was laid until the ship was launched. One yard produced 100 ships in the year 1942.

The ship-construction program for 1942 was equivalent to about 8,000,000 deadweight tons plus of merchant tonnage.

There are about 2000 plans for a destroyer, for example, and they would cover about an acre of ground if spread out at one time.

One manufacturer alone has produced nearly 50 per cent of all the triple-expansion engines used for ship propulsion in the Liberty ships. This plant is now producing one a day of these 135-ton engines.

The rise in munitions production in 1942 over 1941 was substantially as follows:

All munitions	4 times that of 1941
Ordnance	$6\frac{1}{4}$ times that of 1941
Merchant ships	5 times that of 1941
Aircraft	$3\frac{1}{2}$ times that of 1941
Naval ships	$2\frac{3}{4}$ times that of 1941

The machine-tool industry's production is seven times the prewar peacetime peak.

Think of creating in one and a half years, or thereabouts, an entire synthetic-rubber industry to produce from 800,000 to 1,000,000 tons a year.

By the end of 1943, we will have seven times our 1939 aluminum production, and this after fifty years of intensive development, as pointed out by Dr. Charles M. A. Stine, in his fascinating address "Molders of a Better Destiny." He goes on to state:

"We will be recovering from brine or sea water and other sources, approximately 100 times the magnesium that was produced in 1939, when the magnesium industry in America was then 24 years old. After the war the nation's capacity for producing this lightest of all structural metals will be more than double its aluminum output of 1939. We will probably have more aluminum and magnesium capacity than copper and zinc capacity after the production facilities of the lighter metals are completed."

Imagine the management problems in designing and constructing an Army Ordnance Plant, twelve square miles, largely cleared of farms, and erecting more than 700 buildings in a few months. Picture the problems of procurement, of training, and inducting 20,000 workers, a substantial portion of which are women, to man the plant.

The foregoing typifies what is going on in terms of time, volume, and money. Viewed without the vast backdrop of the theater of war, the accomplishment would be stupendous. Ships, tanks, guns, ammunition, airplanes, and power vehicles, to mention only a few wartime products, are all being produced on a gigantic scale; thanks to free enterprise, large-scale production facilities, skilled and semiskilled workers, fine engineering, competent management, and co-operation by governmental agencies.

On the evidence of the record, management has done a good job in spite of all the difficulties, interruptions, and disagreements, many of which were beyond management's control; not perhaps as good a job as needs to be done, management itself is quick to admit, nevertheless a job not to be ashamed of nor apologized for.

To bring the picture into closer focus, let us consider for a

Address presented at the Spring Meeting Dinner, Davenport, Iowa, April 27, 1943, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

moment what the military plane production means in terms of approximate plane-engine horsepower. At the end of 1943, the total horsepower of the engines required for the planes produced in the United States, exclusive of spare and replacement engines, probably will be about 350,000,000 hp. Now that is a figure like the astronomer's unit of measurement—the light year; unless it is related to something one can compare it with, the mind does not take in its significance. This 350,000,000 plane-engine horsepower is probably from $1\frac{1}{2}$ to 2 times the installed central-station capacity of the world and perhaps six or seven times the combined horsepower of the British and United States navies, in 1942.

The Chief of Ordnance of the U. S. Army, Major General Levin H. Campbell, paid his tribute to management by stating at the Annual Meeting of this Society: "The best way to get production results is to turn businessmen loose, wherever possible, on the jobs they know best." As Mr. Lewis H. Brown, president of Johns-Manville, has said, "This expresses a point of view that can be vitally significant, not only in winning this war, but also in winning the peace after the war is won."

"It's unfortunate that more people in government do not recognize the simple fact that we cannot make real progress as long as there is basic conflict between government and business. There should be no real conflict. And as we continue to work side by side in our united efforts to win this war, the shortsightedness of those who would encourage such conflict becomes more and more apparent."

The same philosophy is equally applicable, in my opinion, to the relations of labor and management.

SOME OF MANAGEMENT'S DUTIES AND PROBLEMS

Management is composed of all who are charged with any part of the direction of effort which enables business to function.

Management stability depends upon the equilibrium of the market, men (labor), and money (capital); since management is the co-ordinator of these three factors and the forces generated by them. Under the present wartime conditions, both the market and capital are stable, as the government is the sole buyer of war material and is, to a very large extent, furnishing the capital as well. The unstable factor is labor.

I would not have you think for a minute that labor is entirely responsible for management's dilemma with respect to labor's instability. Much of this is due, in my opinion, to administration policies, to lack of statesmanship on the part of both labor's leaders, the administration, and, in too many cases, to management itself.

Now, what does all this sum up to?

Well, from all the information available, it would appear that the evidence indicates that the United States has accomplished in a little more than two years, from a production standpoint, what it took Japan 30 years to do, Russia 20 years and Germany 10 years.

Now that is no mean accomplishment. Good enough? No. It never will be good enough as long as the present war tempo and the extent of the war theater exist. Management is one of the first to recognize this. So we must put forth still greater efforts, exercise still greater Yankee ingenuity, still more statesmanship, still more co-ordination and co-operation, until the ultimate goal is reached.

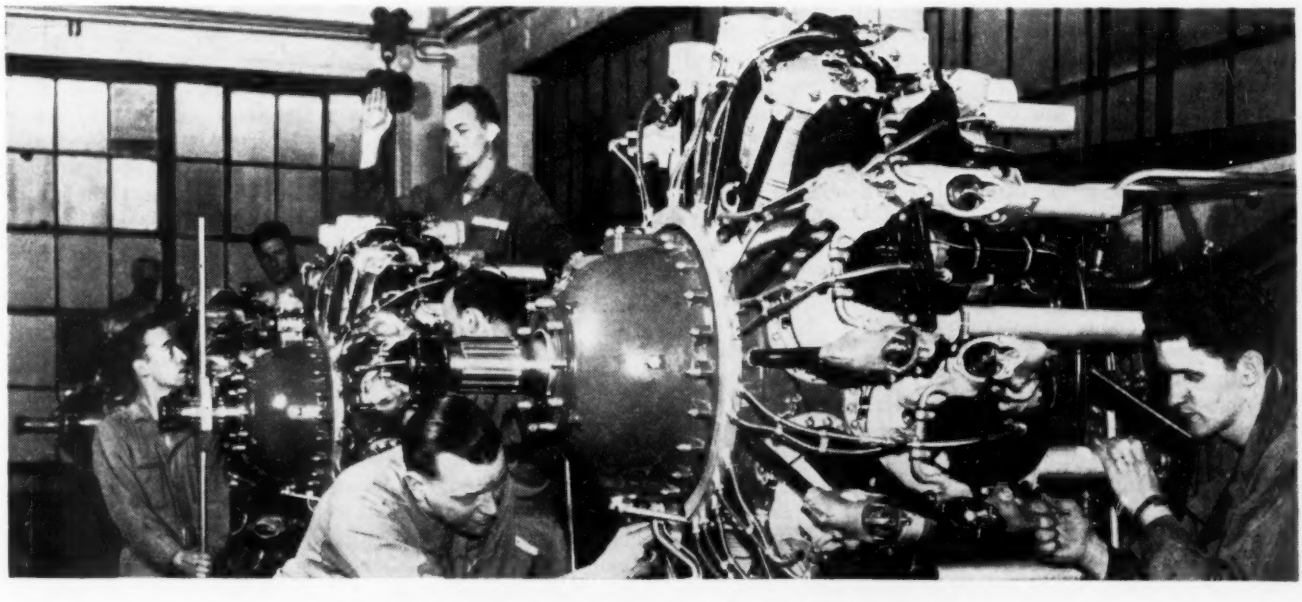
The American people should give fervent thanks that even prior to the events at Pearl Harbor they had the "free-enterprise system," the facilities for large-scale production, skilled workmen, engineering and scientific brains and talent, and competent industrial managers.

The forces of evil and darkness let loose in the world will be overcome and ultimately peace and light will suffuse the earth because one of the major opposing forces of evil is the United States.

It has been quite fashionable in the past to scorn and belittle industry's accomplishments, and, because some few members of it failed to measure up to their responsibilities, to condemn the lot. It has taken this war to demonstrate the innate soundness of American industry and to gain general recognition of the fact that one of the greatest assets the American people possess is their free-enterprise system.

When the Government started to build new industrial plants to augment our existing facilities in the war effort, did it have the necessary engineering, construction, and management talent to design, construct, and operate these plants? No! To whom did it turn for help? American industrial managers. Have they responded? The foregoing analysis proves that they have.

American industrial management has enacted a splendid saga in the two years past. The free-enterprise system will survive and emerge stronger, sounder, and more useful to the people than ever before, as a result of its trial and performance under fire.



FACTORY SCHOOL AT BUICK TRAINS MORE THAN 1500 MECHANICS

(With half a million dollars worth of tools and equipment and live engines on which to test their skills, ground forces of the Army Air Forces rapidly become aviation-engine-overhaul mechanics in the Buick factory school operated in conjunction with the AAF Technical Training Command. The school is exclusively for enlisted personnel.)

A Management Check List for MANPOWER UTILIZATION

By W. H. KUSHNICK

DIRECTOR, CIVILIAN PERSONNEL AND TRAINING, WAR DEPARTMENT, WASHINGTON, D. C.

ALTHOUGH all of us are confident of final victory, we generally may differ in opinion as to what single factor in our total war effort should be emphasized in order to quicken the day of unconditional surrender of our enemies. Some authorities say more cargo ships will shorten the fight; others say more troops will do it; still others argue for more war matériel to Russia and China and MacArthur. One expert calls for more air power, another for more fire power, another for more naval power. Probably the best authority would call for more of all of these. Yet it is significant that one factor is common to all of those needs—it is manpower. To provide more troops, more ships, more planes, more munitions requires more manpower.

But, as you well know, our manpower supply is not too elastic. The War Manpower Commission estimates that during 1943 the armed forces will require an increase of 4,300,000 men. They estimate that the munitions and essential nonagricultural industries will require an increase of 2,100,000 workers during 1943. Of the 6,400,000 additional people required then for both our armed and labor force, only half the required number is expected to be provided by an actual expansion in the working reservoir. Women will have to make up almost all of that expansion. The other half of the 6,400,000 can come only from a reduction in existing employment in less essential industry.

It is obvious, then, that all streams feeding our labor reservoirs must be kept wide open. Resistance to the use of women, in industrial work traditionally performed by men, must disappear. The physically handicapped must be adapted further for industrial production. Prejudice against minority groups must be eliminated.

Yet while all these sources are vitally important, it must nonetheless be stressed that there exists within our working reservoir a vast potentiality for raising its own level. There are now probably more than 43 million persons engaged in all industrial work and even a modest increase in personal man-hour output can make for considerable improvement in our manpower problem.

By suggesting that individual output can be increased I am not unaware that many workers are giving their best of time and skill and energy in their work. To them I would say "carry on," and they will be the ones that will need no prodding to do even better than their best. There are others, however, who need reminding that this is a total war and the nation needs their total and most industrious capacity. Nor do I infer that management is not competent, if output can be increased, but rather that management can meet the challenge of these times by an awareness that manpower economy—effective manpower utilization—is in itself a major contribution to the successful prosecution of the war.

This paper is intended to provide a basis for discussion of how to achieve maximum manpower utilization. Frankly, in all approaches which I have made, in any breakdown or summary I have made, it leads me inevitably to the answer that maximum manpower utilization and good management are synonymous. Effective manpower utilization calls for economy in personnel, for maximum individual output, for proper skill employment, and so does good management. In peacetime, sessions like these emphasized sound management policies and practices for improving our standard of living, for reducing prices, for increased profits. Today those purposes still maintain, but today there exists the even more important motive of releasing the drain on our manpower resources so as to bring an earlier victory.

The accompanying check list is not complete by any means. Perhaps you will want to expand it or rearrange it. You will observe that it calls first for a sound organization structure geared to provide operating officials with staff activities for scientific management. It calls next for engineering to secure manufacturing economy. In these two aspects of manpower utilization a group such as this needs no coaching from me. Therefore I shall direct my remarks to the remaining items on the check list which fall most naturally in the field of personnel management.

Hiring for employment stability in these wartimes requires a program which is consistent with the military demand for fighting men. It means tapping sources such as overage men, women, and the physically handicapped. It means also adoption of plans for part-time employees, split shifts, and other means of increasing the productive capacity of the nation for war and civilian necessities. Inasmuch as womanpower must become our major source of new recruitment, it may be well to make some observations with respect to adjusting industrially inexperienced women workers. They are exceedingly adaptable; they are dexterous, accurate, and good at repetitive tasks. They can be trained to do almost any job you have. However, in many plants, particularly those which have had virtually no women workers, the hiring of women must be co-ordinated with providing facilities, working conditions, and supervision which are favorable to keeping women happy on the job. She usually needs more orientation into shop practices and safety regulations. In particularly arduous jobs rest periods should be provided. She is probably more conscious of cleanliness and orderliness. None of these principles is essentially peculiar to the employment of women; they are important also for men. Since, with some of us, the woman factory worker is a relatively new experience, it is worth stressing that, if properly hired, properly trained, and intelligently handled, women employees are highly efficient and reliable workers.

The next item on the check list is placement. A sound program for putting the right person in the job obviously pays dividends, yet it is amazing how frequently good placement is left to luck. And then there is wonder why production isn't what it should be or why turnover is so high. Personnel offices can be most helpful, but the placement job needs the active support of line management. In these days of scarce labor supply, placement requires a careful determination of the minimum qualifications and experience for the job, requires the current and continuous inventory of the knowledge and skill of those in our employ. It means the acceptance of temporary complications to enable the transfer of employees to jobs for which they are better suited. Where good placement is practiced, the

Contributed by the Management Division and presented at the Spring Meeting, Davenport, Ia., April 26–28, 1943, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

management job of obtaining maximum individual output is easier. Each of us works best, with less need for external stimuli, when physically and spiritually we are in harmony with the work to which we are assigned.

The fifth item on the check list deals with economy in the higher skills. If a good placement job has been done, employees are probably working full time at their highest skills. But even with that, in these days of critical scarcity of journeymen skills in the mechanical trades, it is necessary to go further toward job breakdowns in order to multiply the range of activity of those with the higher skills. Engineers are at home in this phase of our inquiry because they have worked miracles with the transfer of human skill to the machine. The job analysis preceding that transfer is the same condition precedent to dilution of journeymen skills. Where volume permits, there is ample opportunity to train quickly machine operators for one or more repetitive operations, reserving the journeymen for setups, for general supervision of the work of the specialists. Much has already been accomplished in this direction. The developments must be furthered, particularly if we seek to get immediate output from inexperienced women and others.

The sixth item is training. The A.S.M.E. Committee on Education and Training has conducted a session on this subject at this meeting, and hence it will not be necessary to elaborate on the facilities which exist for you to use in your training programs. But it is worth stressing that training doesn't stop when an unskilled worker is brought to a satisfactory state of performance on his job. Training must be comprehensive and continuous for the entire organization. When we analyze what management really is we arrive at the definition that management is the responsibility for getting things done through the efforts of people. Management then achieves its maximum results by a continuous development, or training, of its people. Training starts with the manner in which we induct a new employee, so that he appreciates the purpose of his job and its relationship with the total objective of the enterprise. It carries on through his first job assignment and through upgrading programs. It extends most necessarily to first-line supervisors, who must know the art of instruction and the art of leadership. It includes all echelons of supervision to the very top executives. Training is the very life stream of a company's progress, and, if it is well planned and well supported from the top, it probably can be the greatest force of any, in effective manpower utilization.

No check list which aims at securing manpower utilization in terms of maximum output per employee can exclude proper wage and salary administration. When pay scales are consistent with community rates, when the internal alignment is correct, when there is equal pay for equal work, and where financial incentives can also be provided, then employees work in an atmosphere of financial security and of confidence in fair treatment. When such conditions exist, management objectives are easier to obtain.

A substantial wastage in the utilization of employed manpower comes from absenteeism, the eighth item on the check list. Much has been said and written on that subject. Involuntary absence attributable to sickness and accidents is not too easily controlled. Yet management must do its part aggressively in featuring safety and health education. Notable records in the reduction of lost time resulting from accidents and sick leave have been made by progressive companies. However, I doubt the serious extent of voluntary or willful absence, but there is some absence which may be considered semivoluntary which management can help to reduce. It arises from the longer work week, from inadequate housing and transportation, and from the lack of readjustment of community services, such as shopping, movies, etc., to meet new employment conditions. Management tends to feel that interest in these external factors which influence the lives of its employees may smack of paternalism, yet, if it is paternalism, it is highly profitable in terms of better attendance and more production. Particularly now with the employment of women workers is it necessary to be more comprehensive in our personnel management, and that interest must extend even to promoting community facilities for child day care.

Let us now turn to another waste of manpower—avoidable turnover. The causes of turnover stem from so many sources that in these few minutes we can only observe that management owes it to itself to study the true causes. Altogether too

(*Continued on page 432*)

A MANAGEMENT CHECK LIST FOR MANPOWER UTILIZATION

(Favorable indications are listed beneath each question)

(1) *Are you organized for efficient management?*
- Clearly defined organization structure; well described duties and responsibilities
- Sound budget planning and cost control
- Positive scheduling and production control
- Influential personnel management
- Adequate quality standards and control
- Active methods improvement

(2) *Are you engineering for economy?*
- Extensive labor-saving and materials-handling devices
- Straight-line flow of work
- Simplified procedures and methods
- Proper heat, light, ventilation, and facilities

(3) *Are you hiring for stability?*
- High percentage of women
- Men who are ineligible for the draft
- Physically handicapped are being adapted

(4) *Are you placing for skill utilization?*
- Employee-skill inventory kept current
- Practical tests and performance ratings
- Continuous upgrading

(5) *Are you economizing in high skills?*
- Diluting skills (job breakdown)
- Working employees fully at highest skills
- Absence of hoarding of skills

(6) *Are you training for increased productivity?*
- Constructive orientation of newcomers
- Clear lines of promotion
- Understudies for key jobs
- Executive training
- Supervisory development programs
- Skill training
- Personal performance reviews

(7) *Are you paying to get maximum output?*
- Continuous job evaluation
- Financial incentives

(8) *Are you assisting to maintain good attendance?*
- Employees given help on housing, transportation, child care, and other community services
- Safety and health education
- Recreational programs

(9) *Are you analyzing for reduced turnover?*
- Counseling activities
- Exit interviews

(10) *Are you programming for sustained individual effort?*
- Labor-management committees
- Grievance machinery
- Suggestion system
- Nonfinancial incentives
- Capable supervisory leadership

SYNTHETIC RUBBER

By L. F. MAREK

ARTHUR D. LITTLE, INC., CAMBRIDGE, MASS.

Introduction

With the annual production of nearly 1,000,000 tons of synthetic rubber, in accordance with the Government's present program, this synthetic organic product will be exceeded in tonnage by such basic inorganic chemicals as sulphuric acid, caustic soda, soda ash, but will not even be approached in value by any other chemical product. At 35 cents per lb the value of this ultimate annual production will approach $750,000,000.

The amounts of critical materials and labor required in the erection of plants and in the production of this commodity in competition with other wartime needs are staggering. The entire program has had to be set up under the extreme pressure of war conditions with no time allowed for orderly planning, and with little or no pilot-plant experience. Furthermore, there has been very powerful competition for equipment and supplies. It is now clear that the impact of this competition has delayed the program and may delay it still more to the point of a crisis.

Strictly speaking, no material has yet been produced which warrants the name of "synthetic rubber," at least in the sense in which we speak of many other synthetic substances. Synthetic indigo is identical in every way with the dyestuff prepared from the indigo plant. Synthetic camphor is likewise identical with the material obtained from the camphor tree. However, none of the hundreds of more or less rubberlike substances which have been developed is exactly like rubber, either in its chemical composition or physical behavior. Hence, "synthetic rubbers" are in reality rubber substitutes.

All of these materials, synthetic and natural, are high-molecular-weight long-chain structures built up by the combination or polymerization of many smaller molecules or units. Natural rubber is built up from units of isoprene, a five-carbon-atom unsaturated hydrocarbon. Buna-S is made from the combination or copolymerization of two different kinds of molecules, one a four-carbon-atom unsaturated hydrocarbon, butadiene, and the other a substituted benzene hydrocarbon, styrene, used in the proportion of about 3 or 4 to 1, respectively. Butyl rubber is made almost wholly from isobutylene with a small but very important proportion of isoprene. The other synthetics are made from still other kinds of building blocks.

The products differ from natural rubber in chemical structure and in some cases in chemical composition; they differ in physical properties and in behavior during processing.

The Government owns title to all of the plants (except a few small ones which had been started before the war by private enterprise). It buys the raw materials, directs shipments, choice of processes, and production rates, owns the completed rubber, and allocates it to users.

Commercial concerns are only contracting agents of the Government to carry out the research and manufacturing operations. Only the Government could have financed the undertaking and forced the pooling of patents and technical skills.

At present this is a war industry but, after the war, the plants will be for sale, generally to the concerns now operating them, who have options to buy.

A definite pattern has been followed in setting up the program, partly to forestall monopoly but mainly to insure an adequate supply of materials. Three major groups, with several concerns in each are involved in the manufacturing phase, and numerous concerns have carried out design, engineering, and construction operations.

The achievement of the tremendous production could not have been even expected but for the co-operative efforts involving many companies in several industries. Broadly, three groups are participating in the major Buna-S program, chemical and petroleum companies to supply the raw materials, styrene and butadiene, respectively, and the rubber companies to perform the polymerization to rubber and to manufacture goods from the product. This unique co-operative effort on such a grand scale should promote an intensified interest in the industrial possibilities of hydrocarbon chemistry beyond that involved in the rubber program alone.

Scope of Program and Costs

A yearly value approaching $750,000,000 for the synthetic-rubber product begins to approximate the value of all general chemical production, which for 1939 was equal to $938,000,000, exclusive of plastics, soap, drugs, rayons, oxygen, and acetylene. The volume is over twice that of the plastics production of 1941 (400,000 tons).

The cost of the present construction program is estimated to be somewhere between $500,000,000 and $600,000,000 for the immediate plant to produce the raw materials and the finished polymer. With expansions and possible need for Government financing of rubber-processing equipment, the total may come to $900,000,000 or more, and of course back of the immediate plants are the plants which produce the basic raw materials, namely the petroleum gases, alcohol, etc. These latter are not included in the cost estimate.

The petroleum companies and the chemical companies produce the component materials, butadiene and styrene, under contract with the Rubber Reserve Company on a cost-plus-fixed-fee basis, with the fee graduating downward from 0.69 to 0.335 cents per lb.

The rubber companies operating polymerization plants are to receive fees ranging from 0.7 cent to 1.5 cents per lb.

Various estimates have been made regarding costs of producing the raw materials and the finished products, partly for the purpose of comparing the several methods available for raw-material manufacture, and partly for comparison of potential synthetic costs and natural-rubber delivered prices. Some of these estimates of manufacturing costs are given in Table 1.

TABLE 1 ESTIMATES OF MANUFACTURING COSTS OF VARIOUS SYNTHETIC RUBBERS

Butadiene from petroleum (cost per pound):	
Present stage of development	18 Cents
Potential large scale	6 Cents
Potential average	11 Cents
Butadiene from alcohol (present cost per pound):	
Synthetic alcohol at 19 to 25 cents per gal	13 Cents
Fermentation alcohol at 42 cents per gal	22 Cents
Buna-S (GR-S) from petroleum (cost per pound):	
Present stage of development	About 30 Cents
At maximum efficiency	About 20 Cents
Butyl (GR-I) (cost per pound):	
At start of large-scale production	20 Cents
At maximum efficiency	10–15 Cents

Synthetic rubber produced in Government plants is completely allocated and, early in 1943, the following prices and production rates were set:

Presented at a meeting of the Boston Section of The American Society of Mechanical Engineers, Boston, Mass., January 14, 1943.

GR-S (Buna-S) estimated production rate of 2000 tons per month by January, 1943. Rubber Reserve price to be 36 cents per lb f.o.b. shipping point, April 1, 1943.

GR-I (Butyl) production in December, 1942, was 600 tons and production is to be at an increasing rate to January, 1944, when full production is expected. Rubber Reserve price is to be 33 cents per lb f.o.b. shipping point on April 1, 1943.

GR-M (Neoprene-GN) old production in October, 1942, was 700 tons and new production in October, 1942, was 800 tons giving a total of 1500 tons per month with further increases expected in 1943. The material was available for sale in October, 1942, from the du Pont operated plant at Louisville, Ky., at a price of 65 cents per lb f.o.b. shipping point. This price was reduced to 45 cents per lb, effective April 1, 1943.

Buna-N, present plant capacity is 1500 tons per month; production in late 1942 was at the rate of 1000 tons per month. Production has been limited due to limited acrylonitrile supply which is expected to increase in 1943.

Thiokol production of type FA in late 1942 was at a rate of about 250 tons per month.

Vinyl polymers are important as rubber substitutes, because of their general rubbery properties. Production of all vinyl polymers was at a rate of 2500 tons per month in late 1942 and was expected to increase to 3500 tons per month on the basis of expansion in Koroseal and VYNW capacity. A price of 45 cents per lb is quoted for VYNW (vinyl chloride-acetate resin), March, 1943.

Crude Rubber. Rubber Reserve Company's selling price of crude rubber will be based on 40 cents per lb for IX ribbed smoked sheets from April 1, 1943, for all uses other than civilian goods. This price for crude rubber is said to reflect only in part the higher costs of imported crude from most sources now available, as compared with the costs of Far Eastern rubber when the Rubber Reserve Company stock pile was built up.

NATURE OF THE PROBLEM

Net imports of crude rubber into the United States during the decade 1931–1940, averaged about 500,000 tons a year and constituted more than one half of the world's supply. Of this rubber, approximately 95 per cent of the imports come from the Far East; and of these, regions supplying 90 per cent of the imports are in the hands of the enemy. The remainder of our rubber supply came from South and Central America, Africa, India, Ceylon, and other localities. This country is definitely a "have-not" nation with respect to natural rubber and, although we are the major customer, we have had little to say about production or prices.

Although our vulnerability was recognized, there are several reasons or causes why more was not done to accumulate a stock pile of crude:

1 The International Rubber Regulation Company had in major degree curtailed crude production during the years when accumulation could have occurred. Production thus was limited in 1938 to 45 per cent of the capacity yield, in 1939, to slightly under 60 per cent, and in 1940, to 83 per cent. This resulted in smaller world stocks of rubber and made any net accumulation of stock piles difficult.

2 It was expected that Singapore would hold off any invasion of the East Indies and, as a naval base, would insure safe sea lanes from that region to America.

3 Even if the amount of crude available from the Indies had been adequate for large net accumulations, it is doubtful if any private capital would have been adequate to finance a larger amount of rubber, and certainly no governmental agency would have undertaken the stockpiling of, say, 5 or 6 years' supply (3,000,000 to 5,000,000 tons of rubber costing approximately $1,500,000,000) at a time far enough in advance to make the supply available for such accumulations.

At the time of becoming involved in the war, our normal rubber consumption had risen to over 600,000 tons per year, and our consumption was growing rapidly because of the war demands of our lend-lease friends and our own increasing military demands.

As it was, we entered the war (beginning 1942) with a stock pile of only 650,000 tons or about a year's normal peacetime requirement. By July, 1942, this had already shrunk to 578,000 tons; by November, 1942, to 465,000 tons; and by January, 1943, to 440,000 tons.

Only very small additions can be expected to be made to this crude supply during the emergency, and very large military demands will be made upon it. Thus, based upon the report of the Baruch Committee, the natural-rubber situation may be be summarized as in Table 2.

TABLE 2 RUBBER SITUATION IN SUMMARY

	Tons
Natural rubber on hand July 1, 1942	578,000
Estimated imports July 1, 1942 to Jan. 1, 1944	53,000
Total supply	631,000
Estimated military and other essential demands July 1, 1942 to Jan. 1, 1944, with no allowance for civilian car tires	842,000
Deficit to be met by synthetic-rubber substitutes before Jan. 1, 1944	211,000

For civilian use there is, of course, the existing backlog of tires now on automobiles and trucks, possibly plus the new tires in dealers' hands, and plus the tires being made available by the OPA from the idle-tire turn-in and from those currently being made and rebuilt. Also, the civilian may have his tires recapped or retreaded as required. This situation is summarized in Table 3.

TABLE 3 TIRE SITUATION IN SUMMARY

Registrations 1942:	
Passenger cars	27,000,000
Trucks and busses	5,000,000
Total	32,000,000
Tires at 5 each on vehicles	160,000,000
Tires on cars in dealers' hands	1,500,000
Tires held by manufacturers, mass distributors, and dealers, Sept. 30, 1942:[a]	
New passenger-car tires	9,018,228
New truck tires	1,636,232
New passenger-car tubes	9,870,864
New truck tubes	2,064,102
Tires, O.P.A., idle turn-in	10,000,000
Condition of latter:	
Good = 20 per cent	
O.K. for resale = 70 per cent	
Scrap value only = 10 per cent	

O.P.A. TIRE-PRODUCTION SCHEDULE

	Dec., 1942	Jan., 1943
Grade 1 (for cars with gasoline ration of over 1000 miles per month)	126,000	161,000
Grade 2 (for cars with gasoline ration of 560 to 1000 miles per month)	368,000	230,000
Grade 3 (for cars with gasoline ration of 560 or less miles per month)	92,000	690,000
Truck tires	340,220	366,307
Truck recaps	149,520	368,000
Recapping	887,245	.....

[a] *National Petroleum News*, Jan. 27, 1943, p. 24.

Civilians normally get 48,000,000 new tires per year, or 4,000,000 per month. In 1943, they will get only 30,000,000 of all kinds, experimental, leftovers, recaps, retreads, reclaims, etc. Practically all cars become eligible for tires or recaps, based on the tire-inspection program.

BACKGROUND OF SYNTHETIC-RUBBER PRODUCTION

The burden of supplying the deficit between supply and demand for rubber must be borne by synthetic-rubber substitutes. It will be reassuring to note that synthetic rubber is no new thing, that technicians have struggled for years to adapt the synthetic materials to the construction of tires, and that experience was already being gained in this country at the time of Pearl Harbor.

The British were pioneers in studying the chemical nature of natural rubber and over a hundred years ago had succeeded in breaking down rubber into its structural units. Then about seventy-five years ago, scientists succeeded in reversing the operation and produced viscous elastic masses from these structural units. But it was not until about the turn of the century that an independent source of these structural units was discovered in the products from the cracking of turpentine.

In 1912, a short-lived commercial enterprise was started in England to make synthetic rubber from butyl alcohol obtained by fermentation of starchy substances like grain and potatoes. The low price of crude, however, prevented real commercialization.

The Germans began activities as early as 1900 and by 1910 had made rapid progress. Patents issued to the German chemical companies began to appear in rapid succession. In 1912, a pair of automobile tires made from German synthetic rubber by the great dye trust was exhibited in New York at the International Congress of Applied Chemistry.

The German government had largely subsidized the research and development in this field as a matter of military necessity, and during the first world war the Germans produced over 2000 tons of usable synthetic rubber.

Russian scientists were also active but did not push development to commercial stages in this early period.

Modern developments date from about 1925, with intensive work in Germany to develop a substitute for rubber in all ordinary uses, and with the work of the du Pont Company in this country to develop a material superior to natural rubber, particularly with respect to resistance to oil. Both of these programs were successful, the du Pont effort leading to the production of a special rubber first called "duprene," now named "neoprene," and the German effort leading to the synthesis of a series of Buna rubbers, both efforts, curiously enough, starting with acetylene as a basic raw material. Some of the German material was even imported to this country in 1938, to supply users of neoprene when its supply was temporarily shut off by an explosion which wrecked the du Pont plant.

By 1932, the Russians were busy making road tests of tires made from their SK synthetic rubber in various combinations with natural rubber, and from certain Russian natural rubbers. Russian production of synthetic rubber was estimated at 50,000 tons in 1941. Russia has also produced a variety of neoprene called "sovprene."

When war came to the United States on December 7, 1941, several types of artificial rubberlike materials, synthetic rubbers, were already being made commercially, among them some that had several years of commercialization, and others that had but a short life history but were destined to play important roles in the months to come. Thus may be mentioned:

Neoprene, made by the E. I. du Pont De Nemours & Company, Inc.

Thiokol, made by the Dow Chemical Company for the Thiokol Corporation.

Koroseal, made by the B. F. Goodrich Company.

Buna, made by Standard Oil Company of New Jersey and two licensees, Firestone Tire and Rubber Company and the United States Rubber Company.

Chemigum, similar to Buna and made by Goodyear Tire and Rubber Company.

Vistanex, made by the Standard Oil Company of New Jersey.

Butyl, not yet in commercial production, but for which a plant was under construction by Standard Oil Company of New Jersey.

Production, by private enterprise in the United States, of special-purpose synthetic rubber had been as follows up to the time of our entrance into the war:

1939, about 2500 tons
1940, about 5000 tons
1941, about 12000 tons

Thus the maximum that had been produced in any one year at the time we entered the war and our supply of natural was beginning to be shut off was only about 2 per cent of our normal peacetime requirements. However, we had certain experience and a wealth of raw materials.

Some of the American rubber companies had been conducting research directed to the production of specialty synthetic rubbers and had advanced beyond the pilot-plant stage in the production of butadiene-based synthetics. Goodyear had developed "chemigum" and Goodrich had produced "ameripol." Both companies had built and tested tires made from the synthetics prior to 1941. Goodrich also entered into a joint enterprise with Phillips Petroleum Company and formed the Hycar Chemical Company to produce the oil-resisting synthetic, "Hycar OR." It is said that this private Hycar enterprise has produced to early 1943 as much butadiene-type rubber as all of the other butadiene rubber plants combined.

On May 15, 1941, the Defense Plant Corporation entered into contracts with four major rubber companies, Goodyear, Goodrich (Hycar Chemical Company), Firestone, and U. S. Rubber, for the construction and equipment of synthetic-rubber plants which would each have an initial production capacity of only 2500 tons annually, but which could be readily expanded to 10,000 tons annual capacity. On July 1, 1941, the capacities of these four authorized plants were increased to a 10,000-ton annual capacity. Actually, these plants were expected to have capacities of 15,000 tons annually each.

Construction of these plants started as follows: Goodyear in May, 1941; Firestone in July, 1941; U. S. Rubber in September, 1941; and Hycar Chemical in February, 1942. Contracts for the production of raw materials for this limited program were authorized in November, 1941. These plants have come into production about as follows: Goodyear in May, 1942; Firestone in June, 1942; U. S. Rubber in August, 1942; and Hycar (Goodrich) in November, 1942. Goodyear's was the first of the government plants to reach 500 tons production. Limitations in supplies of raw materials prevented full-scale operation.

Since Pearl Harbor, the Government's program has been repeatedly expanded as the foreseen emergency became an actuality. The plants mentioned were first expanded to a total of 120,000 tons per year capacity. Then additional facilities were provided to make a total of, first, 400,000 tons per year, later of 600,000 tons, and still later 800,000 tons, including 60,000 tons of butyl rubber and 40,000 tons of neoprene.

The execution of this tremendous program has naturally brought with it numerous problems, especially those concerned with the production of the necessary butadiene and styrene. The other responsibilities of the petroleum industry in the war effort, especially in regard to the production of aviation fuel, lubricants, and toluene, have had to be considered in relation to this rubber program.

Although the ultimate goal for synthetic production has not been changed in the Goverument's program, the rate of approach to that ultimate has been very materially changed from that visualized by the Baruch Committee. This is because of the impact of the other emergency programs on equipment demands. These other programs include the provision of facilities for aviation-gasoline production, shipbuilding, and aircraft construction.

The situation with respect to the raw-materials supply for polymerization in February, 1943, was that somewhat less than one half of the scheduled program would receive equipment supplies to permit immediate completion. The remainder of the program is planned for completion as equipment availability permits.

Thus, on the basis of the latest available Government estimates for synthetic production and, without taking account of Buna-N or reclaimed-rubber production, the essential requirements of rubber in 1943 will reduce the amount of resultant

stocks of rubber to about 125,000 tons by fall of 1943. A delay of only a few weeks in the on-stream completion of synthetic plants could easily reduce this small residual to one half or even less than this amount.

Quite obviously, ordinary civilian requirements cannot expect to receive any of this material. Civilian requirements will have to be met by whatever reclaimed rubber is left over after essential uses are satisfied and by whatever Thiokol it is possible to produce for the purpose.

TABLE 4 SYNTHETIC RUBBER 1943[a]

Type	First quarter, long tons	Second quarter, long tons	Third quarter, long tons	Fourth quarter, long tons	Total 1943, long tons
Buna-S	3800	13900	59500	118000	195200
Butyl	100	1500	3300	13500	18400
Neoprene	4400	4900	9100	12000	30400
Buna-N	2900	3900	4800	4800	16400
Total	11200	24200	76700	148300	260400
Crude equivalent	10800	22900	70700	136600	241000

[a] 1943 estimated production of synthetic rubber, including neoprene and Buna-N from private plants, according to Progress Report No. 2, Office of the Rubber Director, February 18, 1943.

RAW-MATERIAL SOURCES

In the full program set up by the Government for synthetic rubber, petroleum sources play a major part. In the present emergency program, considerable emphasis has been placed upon the production of butadiene from alcohol, because of the apparently greater speed of production which can be achieved with the least critical-equipment requirements.

Thus, for butadiene production, the present program, February 18, 1943, Progress Report No. 2 from Rubber Director Jeffers, is as follows:

From:	Short tons
Alcohol	220000
Butane	75000
Butene by dehydrogenation	265100
Naphtha cracking (refinery conversion)	96760
Total	656860

Styrene production will be from benzene and ethylene, with the benzene derived partly from petroleum and partly from coal distillation. Production will be divided[1] as follows:

	Short tons
Dow Chemical Company	79200
Koppers United	37500
Monsanto Chemical Company	50000
Carbide & Carbon Chemicals Co.	25000
Total	191700

[1] *Chemical and Metallurgical Engineering*, Feb., 1943.

This combined production of styrene and butadiene will be sufficient for the ultimate production of over 700,000 long tons of GR-S. This is a reduction from the 845,000 long tons recommended in the Baruch Committee Report.

For the other synthetics to be made, the sources are as follows:

For GR-I (butyl):
Isobutylene from petroleum—about 65,000 tons
Isoprene from turpentine or petroleum—about 3000 tons
For GR-M (neoprene):
Acetylene from carbide—30,000 tons
For Thiokol:
Ethylene for dichlorethylene from petroleum—20,000 tons

If all of the synthetics were made from petroleum, the peak objective of 1,000,000 tons per year would represent only 0.5 per cent of the total petroleum production of the United States in 1940. Hence, ultimate material supplies are adequate for almost any production program.

PROPERTIES AND USES OF SYNTHETIC RUBBER SUBSTITUTES

The various synthetics differ from natural rubber and from each other in both chemical structure and physical behavior. The differences are such that the several substances are not generally interchangeable in use or in fabrication. Special properties unique to the several synthetics adapt them to certain uses better than to others. Much remains to be developed with regard to the best ways in which to utilize fully these special properties.

The summary given in Table 6, based upon the Supplementary Report of the Baruch Committee, characterizes the more important synthetics relative to natural rubber with respect to use in automobile tires.

It has been predicted that as the manufacture of the synthetics is perfected and as more is learned of how they can best be used, tires capable of giving 100,000 miles of service will be produced. This is on the basis of selecting the best ones, of course, and already some of the synthetics are superior to natural rubber in one or more of the following respects:

(*a*) Higher resistance to gasoline, oil, etc.
(*b*) Greater stability to light and air.
(*c*) Greater wearing quality.
(*d*) Higher sidewall strength.
(*e*) Greater road grip (frictional resistance greater).

There are, however, some real problems to be overcome in the adaptation of methods and equipment developed for natural rubber for use with the synthetics. Among these problems are to be noted those associated with the greater difficulty of milling Buna-S (GR-S) and of mixing in compounding materials like carbon black. This is due to the greater stiffness or "boardiness" and to the lack of plasticization of the synthetic by "breakdown" when milled in the usual way. This also applies to the sheeting and tubing of such synthetics.

Other problems derive from this physical nature of GR-S, especially the lack of tack or adhesion of the unvulcanized material. This results in a tendency for separation of plies in built-up structures such as automobile tires.

Another difficulty has been the tendency for vulcanizates to generate heat and undergo temperature rises when subjected to flexure or working. Such heat build-up aggravates the tendency for different plies to separate and also accelerates the deterioration of articles during use.

TABLE 5 PRODUCTION OR ADDITION IN LONG TONS

Year	Natural	Buna-S	Neoprene	Butyl	Thiokol and Buna-N	Reclaim	Total synthetic
1939	...	....	2000	....	500	....	2500
1940	...	....	5000	....	500	....	5500
1941	...	1250	9000	....	1750	....	12000
1942[a]	...	8000	12000	300	12000	....	32300
1943[b]	41000	386000	30000	62000	54000	360000	532000
1943[a]	...	281000	21000	21000	15000	....	338000
1943[c]	...	....	...	....	...	....	300000
1944[b]	68000	705000	59000	132000	60000	400000	956000
Baruch objective[b]	...	845000	60000	132000	60000	....	1097000
Rubber Reserve Co. objective[d]	...	705000	40000	68000	?	...	813000
Now under directive including plants built or building[d]	...	435000	10000	7000	...	...	452000

[a] Estimate by *Oil and Gas Journal*, July 23, 1942.
[b] Baruch Committee Report.
[c] Dewey before Gillette Committee, Nov., 1942.
[d] Rubber Progress Report No. 2, Feb. 18, 1943.

TABLE 6 USE OF VARIOUS SYNTHETIC RUBBERS IN TIRE MANUFACTURE AS COMPARED WITH NATURAL RUBBER[a]

Type of rubber	Manufacturing efficiency,[b] per cent	Use as tread	Carcass failures	Use as recap	Use as inner tubes
Buna-S	Mix. 40–70 bldg. 80–100 cure 100	90 per cent as good as natural	None—if 10 per cent natural used	90 Per cent as good as natural	Apparently satisfactory
Neoprene	Mix. 40–65 bldg. 75–100 cure 50	90 per cent at normal speeds, 125 per cent at excess speeds	No failure recently	90–110 Per cent as good	Apparently satisfactory
Butyl	Mix. 100 bldg. 100 cure 70–75	40–50 per cent as good as natural	Failures due to blisters	Adhesion poor but will be improved	May be developed—only fair now
Flexon	Same as butyl	Poor; only 40 per cent	Same as butyl	Promising	Unsatisfactory
Thiokol	.....	Poor; only 28 per cent as recap	.....	Fair—but curing time longer	Unsatisfactory
Reclaim	Same as natural rubber	Poor; only 20–25 per cent of natural	No trouble	Fair—cure time same as natural	Fairly satisfactory

[a] Based on Appendix II to the Baruch Committee Report.

[b] The percentages given refer to the amount of synthetic material which can be mixed with compounding ingredients, built into finished articles, and vulcanized to products with a given amount of equipment in a given time relative to natural rubber.

In the effort to overcome these shortcomings and still produce a useful composition, much effort has been and is being directed toward the use of specially suitable compounding agents. As an example, it has been found that the use in tire treads of furnace-type carbon blacks instead of the usual channel-type blacks, reduces the tendency for heat build-up, increases the mixing efficiency, and does not seriously detract from use properties of the vulcanized product. In consequence of this discovery, the furnace type of carbon black has become of great importance, and producing capacity is being rapidly expanded to a total which will soon approach that of the channel-black capacity before the emergency.

These two types of black are different in production and properties. Channel black or reinforcing black is produced in yields of about 1.5 lb per M cu ft of natural gas by the deposition of carbon on steel channels from thousands of small smoky flames located directly underneath the channel. The carbon is continuously scraped off and collected. Mixed into natural rubber, this type of black produces superlative reinforcing effects, increasing tensile strength and resistance to abrasion and increasing the stiffness of the product. In the synthetics, the use of all channel-black compounding aggravates the tendency for the rubber to heat up when flexed and tends to overstiffen the product. Furnace blacks are produced in special furnaces in yields as high as 12 to 14 lb per M cu ft of natural gas. Usually, in these furnaces, sheets of gas burn with a free flame in a limited supply of air and the black is collected in bag filters or by electrostatic precipitation. These furnace blacks do not have as high a surface area or as fine a particle size as the channel blacks and are only semireinforcing in effect in rubber use. However, they may be used in larger proportion and also in conjunction with some channel black.

At present, there is a large surplus of channel-black capacity. Present furnace-black capacity is about 150,000,000 lb per year with about 100,000,000 lb per year additional capacity already approved; so there would seem to be no possibility of a furnace-black shortage. Estimated requirement for both types of black in 1943 is about 300,000,000 lb.

Of the various other addition or compounding agents, such as vulcanization accelerators, stabilizers, and plasticizers or softeners, the latter especially have received considerable attention. This is partly in an effort to improve the mixing and milling efficiency and partly with the object of improving the adhesiveness of GR-S and the general physical properties of vulcanized compounds. No basically unique plasticizing materials have so far been worked out; in general for the Buna type such materials as selected coal-tar fractions, hydrocarbons derived from the acid sludge of lubricating-oil manufacture, and pine tar and rosin substances have been found most suitable. The W.P.B. test formula for GR-S uses a coal-tar plasticizer.

Accelerators of vulcanization and antioxidants, for the most part, are the same as those used for natural rubber, and hence no problems in supply are expected.

WILL SYNTHETICS DISPLACE NATURAL RUBBER AFTER THE EMERGENCY?

The question as to whether synthetics like GR-S can compete with natural rubber, after international trade is re-established following the cessation of hostilities, is frequently discussed. There is no doubt that synthetics having special properties, such as the butadiene-acrylonitrile copolymer types, neoprene types, and the Thiokols, will survive in competition with natural rubber just as they did before the war forced the present emergency on the United Nations. The question regarding butyl rubber, GR-I, which also has special properties as well as a low production cost, is not so readily answered since there is no prewar history to serve as a basis.

With very low-cost labor assumed to be available in the East Indies plantations, it has been estimated that natural rubber can be produced at from 4 to 6 cents per lb. If transportation and handling costs are then taken at 4 cents per lb, natural rubber could be delivered in this country at 10 cents or less per lb. However, there is no substitute for labor in the production of plantation rubber and, if wage standards are raised in the East Indies after the war, as they may be, the costs of production and hence the delivered costs will be higher than this. The question of import duties on plantation rubber produced with foreign capital has not been discussed, but if such duties are imposed to protect the domestic synthetic industry, they would of course be an important, if not determining, factor.

Economic comparison between general-purpose synthetic and natural rubber on the basis of per pound costs is not strictly correct even for such uses as tire treads since a pound of synthetic may do more or less than a pound of natural in terms of tire wear. There is already evidence that as more is learned about the best methods for producing and using the synthetics, tires will be made which are materially better than the best that can be made from natural rubber. After all, many years of effort were required to bring natural-rubber tires to the present stage of development, and it is unfair to assume that a few months of effort in the use of synthetic rubber would see the exhaustion of the possibilities. Furthermore, it cannot be assumed that, just because Nature produced a rubber which has been adapted to the manufacture of excellent tires, this natural material is the best that can be used for tire treads and other rubber products.

There is also to be considered the insurance provided by a synthetic-rubber industry against the vulnerability of our position with regard to a rubber supply. Even at a differential per pound cost of 15 cents between natura and synthetic general-purpose rubber, the national cost would be only some $240,000,000 on the basis of 800,000 tons per year of such synthetic consumption.

It would seem entirely possible that the natural product will occupy only a secondary position in the postwar period.

FLEXIBLE PRESSURE *in* VENEER *and* PLYWOOD *Work*

The Modern Method of Making Curved Plywood

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CURVED plywood has been made for many years and used in furniture, pianos, radio cabinets, doors, stair risers, and the like. The volume has been quite limited; the devices for obtaining curvature have been relatively simple so that they could be made by the factory mechanic; and the strength/weight ratios were not considered important. Improved methods for producing curves out of prebonded flat plywood, as well as of making curved shapes at the time the layers of veneer are glued into plywood, have both been in the stage of progressive development but, until quite recently, without evidence of particular urgency. An earlier paper (1)[1] by the author, in comparison with the present paper, gives an interesting perspective, indicating the marked progress which has been made in the technique of curved-plywood manufacture.

The distinct realization of the outstanding utility of curved plywood of complex shapes for aircraft, boats, Signal Corps requirements, and other fighting equipment has given substantial impetus to these developments, and the progress made in the past 2 years has been most striking. Since plywood materials, equipment, and manpower were found to be relatively plentiful, its adoption as an alternate for scarcer and more critical metals has greatly accelerated the development of new methods of pressure application for making intricate curved forms of plywood and related materials. The availability of heat-reactive resin adhesives has become another major factor in this expanding plywood program.

At this time, it is possible to examine the principles underlying this new curved-plywood technique, to evaluate them at least partially, and to outline some of the more important methods which have so far contributed to its rapid progress. The program is making such strides that statements of today may be untenable tomorrow, and the visions of this week may become the facts of next. An outline of such industrial progress, as it occurs, needs no defense, nor does its obvious incompleteness require an apology.

PRESSURE IN ONE DIRECTION

The standard method of exerting pressure, when gluing sheets of veneer into plywood, has been the application of pressure in one direction only, i.e., by hydraulic rams or pistons, by pneumatic jacks, by screw presses or clamps, and, in rare instances, by toggle joints. Such pressure is distributed, more or less efficiently, over the area of the glue joint by rigid plates or blocks. This method of pressure application involves adjustments or corrections for certain inevitable differences of thickness which are common to all wood products and are suggested by the following examples:

Veneer lathes and slicers are equipped to cut certain fixed thicknesses, often from logs or flitches which are cooked to the saturation point. It is well known that the shrinkage from such a saturation point, or from normal greenness, to working dry (approximately 10 per cent moisture content) will differ, as between quarter-cut (radial) and plain-cut (tangential), and also will vary between sapwood and heartwood. Furthermore, there is no generally recognized standard for veneer cutting. Some operators cut to full dimension green, resulting in a scant thickness dry, while others allow a fixed shrinkage factor and claim to produce veneer of full dimension when dry. Another phase of the problem is that rough-cut surfaces require more pressure than smooth-cut veneer.

The practical solution to thickness variations, in regular plywood production, is adequate pressure to compress the thicker layers until they match the thinner layers, usually a reduction of 5 to 10 per cent in aggregate thickness being required. This involves the use of more pressure than is needed otherwise and requires the allowance of extra initial thickness in the veneers used.

Another problem in the use of one-directional pressure is that of somewhat curved or recessed surfaces, such as the well-known "Toastmaster" plywood tray, or a conventional barrel stave of plywood. In order to make a proper plywood bond, effective pressure should be exerted in a direction at right angles to the curved surface, or perpendicular to a tangent. Vertical pressure, diverted at an angle, will be reduced in geometric ratio, as can be noted in Fig. 1, which is a diagram published in the original paper (1). Full pressure (e.g., 100 psi) will be exerted at *A*, while at the extremities of a 90-deg angle (as at *B*), the pressure will be of the order of two thirds; at the extremities of a 120-deg angle (as at *C*), it will be one half, and at *D* it will be nil. From a practical viewpoint one-directional pressure can be made effective over a 90-deg angle, sometimes over a 120-deg angle, but there will be a moderate amount of surplus pressure required to compensate for the effect of the curvature.

There are some instances, relatively few in number, where presses or clamps exert pressure in two directions, as in a vertical

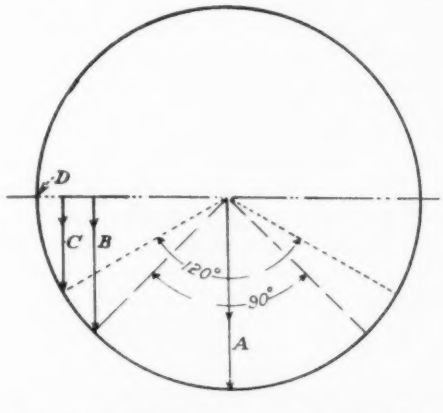


FIG. 1 DIAGRAM FOR VERTICAL PRESSURE

(Indicating effect of curvature on unidirectional pressure, i.e., pressure at *B* is $^2/_3$ that at *A*, at *C* is $^1/_2$ that at *A*, and at *D* is nil.)

[1] This and other important references to technical publications on the art are given in the Bibliography at the end of the paper.

Contributed by the Wood Industries Division and presented at the Spring Meeting, Davenport, Iowa, April 26–28, 1943, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

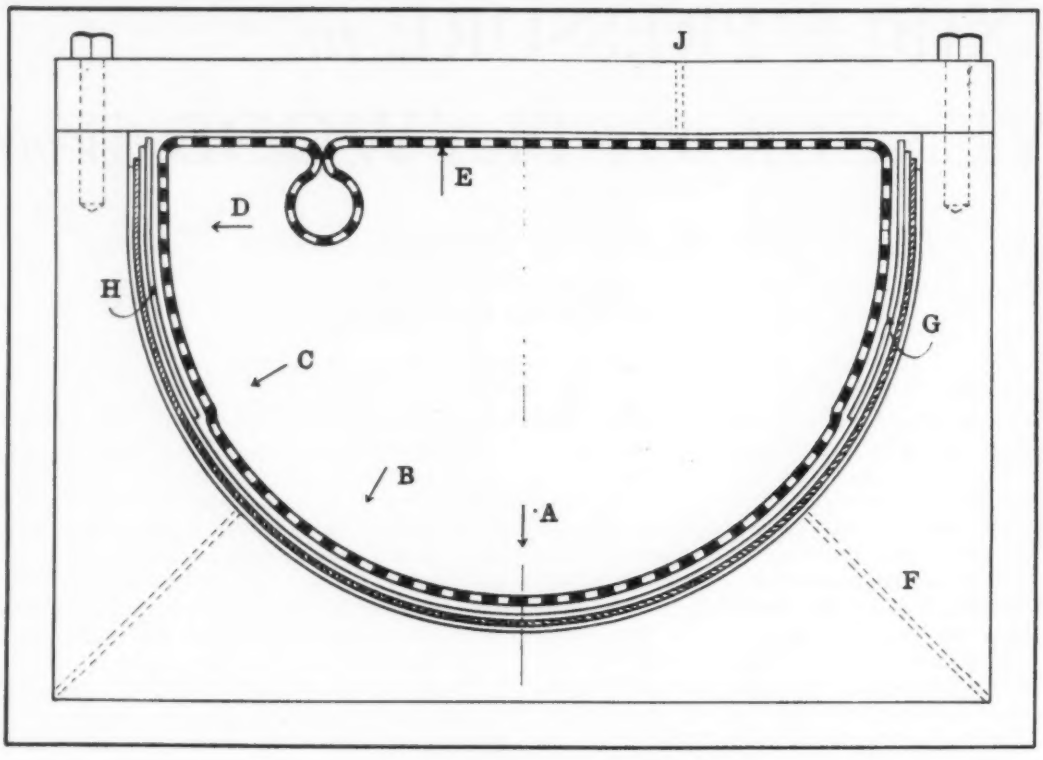


FIG. 2 OMNIDIRECTIONAL PRESSURE

(Indicating that the flexible bag exerts pressure in every direction, and its intensity is equal at *A*, *B*, *C*, *D*, *E*, and other points. Vents are provided at *F*. Overlays are shown at *G* and *H*.)

and horizontal direction, but, in general, these two-way-pressure devices are not important.

PRESSURE IN ALL DIRECTIONS

With this background in mind it is possible to contrast the one-directional pressure through rigid plates, as outlined, with the recent developments in applying flexible pressure with a fluid medium, such as steam, hot water, or compressed air.

Fig. 2 indicates the same plywood construction which could be made with the pressure diagram of Fig. 1. However, in the case of Fig. 2 the pressure is exerted by inflating, through *J*, a flexible bag, as of rubber. As a result it is omnidirectional and with a fluid pressure of 100 psi, it will be noted that this full pressure without any diminution is effective at *A*, *B*, *C*, *D*, and even at *E*. Another result accomplished by this fluid pressure is the elimination of difficulties caused by variations in veneer thickness. In fact extra layers of veneer can be placed at certain locations, as at *G* and *H*, where concentrated stresses may be expected for fastening devices or scarfed joints. If a heat-reactive resin is used, the molds may be provided with steam pipes, or the pressure fluid may be steam or hot water.

In the cross section, Fig. 2, the curvature might be that of a semicylinder, requiring curves in one plane only, or it might be a semisphere or semioval involving compound curves in more than one plane. This latter shell-shape construction has been called "monocoque," and its best example is an egg shell, where strength/weight factors are found to have distinct advantages. In many monocoque designs, bracing or stiffeners are found to be effective in improving strength characteristics, with less total weight than when the shell is thickened throughout for localized stresses. Such braced shells are called "semimonocoque."

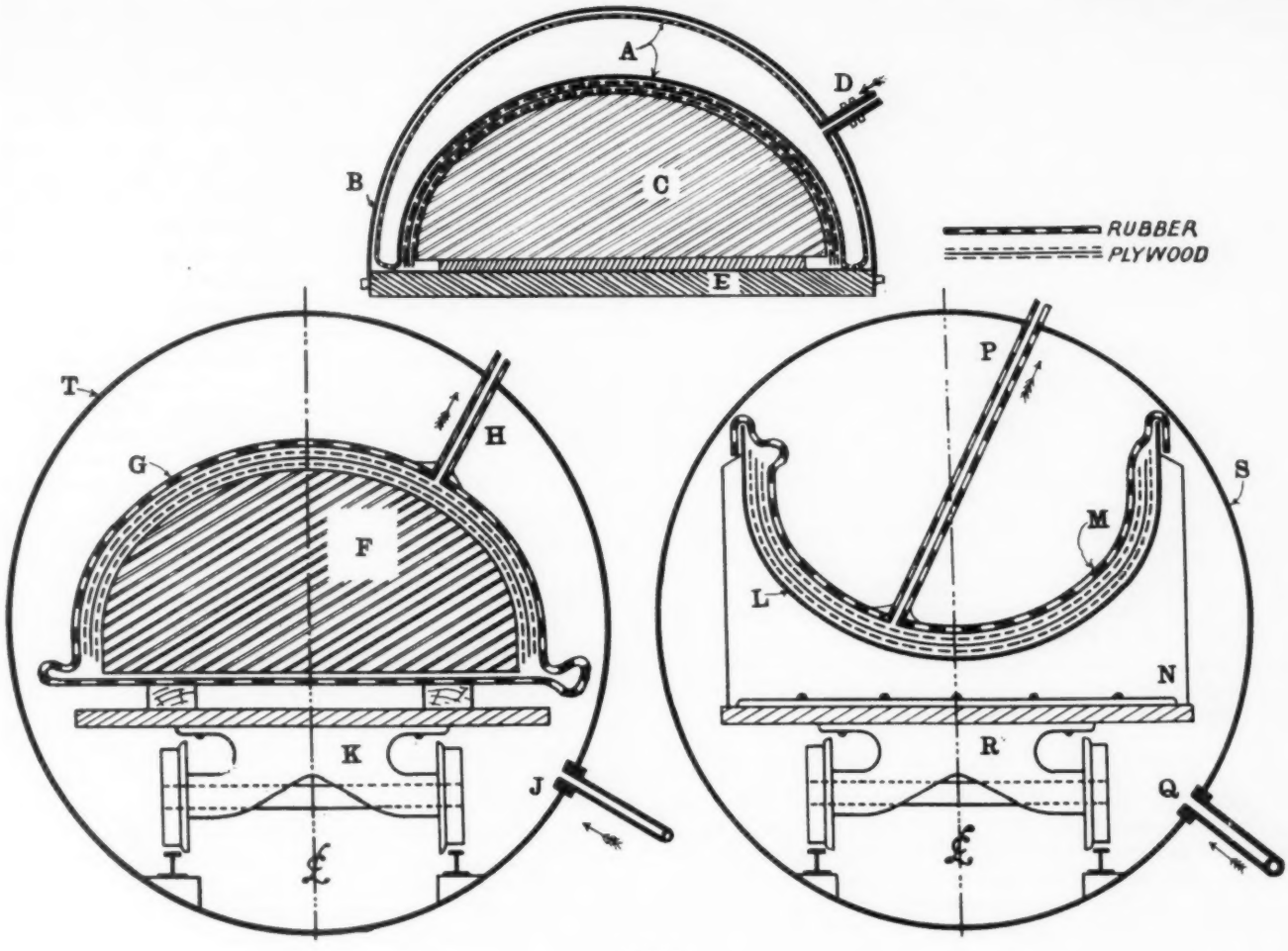
METHODS OF APPLYING OMNIDIRECTIONAL PRESSURE

There are at least three principal methods of making monocoque plywood with flexible pressure bags; (*a*) inflatable closed bag or mattress not containing the plywood; (*b*) deflatable open-end bag containing the plywood; and (*c*) deflatable half-bag, or blanket enclosing the plywood, in which the mold constitutes the other half of the bag.

In order to facilitate their comparison, Fig. 3 illustrates the same plywood shape made by each of these three processes. The cross section of this shape in the sketches might be one half a fuselage or a boat hull. In the case of the fuselage the two halves would be scarf-jointed and bonded into a whole. The shape as shown is intentionally reduced to its simplest form, and actually represents a cross section, in simple curvature, of a cylinder or cone. In practice, this will probably have a considerable amount of compound curvature, for streamlined effects in either aircraft or watercraft. In order to make the details clearer, most of the layers or parts are slightly separated in this and succeeding sketches.

The upper cross section, Fig. 3, illustrates one of the earliest applications of flexible-bag molding to plywood. The convex mold *C* may be of metal (with or without heat), of wood, or of concrete. The veneer layers, of which three are shown, are successively laid (technically wrapped on) against the mold with adhesive between each layer. The outer and inner layers may be lengthwise of the mold, or at an angle of 60 or 45 degrees thereto. The center layer, like a half hoop, may be crosswise, or at a considerable angle to the adjacent veneers. These layers are temporarily fastened in place by tacks, tape, or staples until the adhesive bond is cured. An inflatable rubber mattress, *A*, is laid over the outer veneer, and above this a sturdy semicylindrical steel shell, *B*, is placed which is firmly bolted to the base, *E*. This rubber mattress, or closed bag, is flexible rather than extensible. It is inflated through *D* with steam, hot water, or compressed air, or a combination of these fluid-pressure mediums. The fluid pressure forces the veneer layers together and against the mold at every point and holds them in that position until the adhesive bond is completed. It is necessary that the veneer strips be properly tapered before assembly so that all ends and edges fit closely together.

The cross section at the lower left of Fig. 3 shows the equip-



LEGEND

Upper: Inflated bag on solid mold
A—Inflated rubber mattress
B—Half steel shell to restrain mattress
C—Solid mold, wood or metal
D—Fluid-pressure inlet to inflate mattress
E—Base plate, to which *B* is bolted

Lower Left: Deflated bag on solid mold in autoclave
F—Solid mold, wood or concrete
G—Deflated rubber bag
H—Vacuum or vent connection
J—Fluid inlet, to produce pressure in autoclave K—Transfer car T—Autoclave

Lower Right: Deflated half-bag on shell mold in autoclave
L—Shell mold of metal
M—Half-bag to be deflated
N—Cross frames to keep mold *L* rigid
P—Vacuum or vent connection
Q—Fluid inlet to produce pressure in autoclave R—Transfer car S—Autoclave

FIG. 3 METHODS OF APPLYING OMNIDIRECTIONAL PRESSURE
(Parts separated to show detail more clearly.)

ment necessary to produce the same plywood shape when using an autoclave or cooker comprising a large cylindrical tank with an end door that can be sealed tightly. Here a convex mold *F* (similar to *C* mentioned), with the wrapped layers of veneer temporarily fastened in place, is placed inside the open-mouthed rubber bag *G*, whereas in the first instance the mold and plywood were outside the bag. Any air within the bag, either initially there or caused by subsequent leakage, is exhausted through the vent *H*. The mold *F* and its enveloping bag *G* on the transfer car *K* is placed in the autoclave *T*, continuing the vacuum or vent connection *H* to the outside of the autoclave. Steam, hot water, or compressed air is utilized to produce fluid pressure inside of the autoclave and against the rubber. This applies omnidirectional pressure of equal intensity over the entire curved-plywood surface. Care must be exercised to avoid any air pockets in the vacuum area, which often requires grooves in the mold, or perforated noncollapsible tubes to ventilate otherwise inaccessible spots. A ventilating pad should be located at the vent connection to prevent premature sealing at this point.

There is little difference between these two pressure-application methods, as the intensity of pressure may be regulated equally well in either. In both cases the pressure is applied on the outside or convex side of the curved plywood. However, the amount of vacuum pressure is additional to the positive pressure above atmosphere. The autoclave equipment with transfer car results in somewhat more convenient operations.

The third method, shown in the lower-right cross section of Fig. 3, requires a thin metal mold *L*, the contour of which is braced by frequent cross frames *N*, which in turn are bolted to the platform of the transfer car *R*. In this case the required amount of rubber *M* is reduced to approximately one half, since the airtight metal sheet *L* serves as the other half of the vacuum enclosure. This single layer of rubber *M*, in the form of a blanket, is folded over and tightly clamped at all ends and edges to the thin metal face *L* of the mold. The vacuum connection *P* functions as has just been described, and air pockets must be similarly avoided.

A variant in this third method, not illustrated, is a plywood mold, $\frac{1}{2}$ to 1 in. thick, which serves similarly as half of the bag. Heat penetration through this moderately thin wood is slower than through thin metal but far more rapid than in the case of solid wood molds.

In contrasting this third method with the two preceding ones,

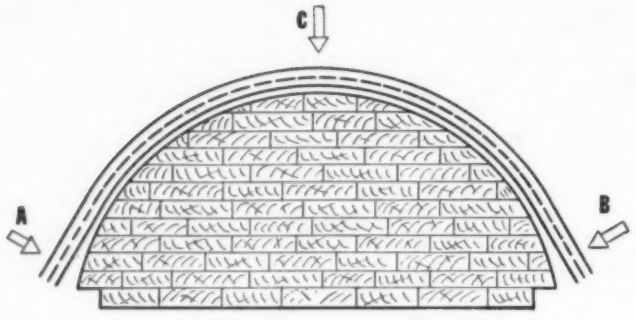


FIG. 4 EFFECTIVE PRESSURE IN FLEXIBLE-BAG MOLDING

(The ineffective pressure at *A* and *B*, neutralized by bending of veneer layers, must be deducted from total pressure at *C* to get net effective pressure.)

it is to be noted that the mold is concave, rather than convex, thus giving the outer or convex side of the curved plywood a smooth streamlined surface, which is a distinct advantage in either aircraft or watercraft. It is also evident that the heat of the autoclave fluid medium is applied to both sides of the plywood, i.e., through the rubber and through the thin metal. This permits shorter curing cycles for the adhesive, since there is not only the double application of heat, but also there is no heavy thick mold to retard the rapid penetration of heat into the plywood.

VENEER VERSUS TWO-PLY LAYERS IN MOLDING

While the larger proportion of molded plywood is made directly from single layers of veneer, there are instances where better results can be obtained from thin 2-ply layers, bonded together flat. Constructions where single layers tend to split easily are examples. Another case is a boat hull, to be made by any of the methods shown in Fig. 3. Here a large sheet of 2-ply layers can be used which will obviate the necessity of handling and fastening many narrow pieces of single ply. Deep gores or vees are cut in the ends of these large sheets of 2-ply layers, so that the edges of the cutouts fit accurately when laid over the mold. Two or three sheets of 2-ply layers are used, and the cutouts properly staggered for strength.

EFFECTIVE VERSUS INEFFECTIVE PRESSURE

One factor, which must be given due consideration in any of these fluid-pressure applications, is the inherent resistance of the wood layers to bending, twisting, or curving. It is a general rule of plywood molding that the radius of curvature should not be less than approximately 75 times the thickness of the individual layers of veneer, hence the veneer thickness becomes an important design factor. A simple illustration of this resistance of wood to bending into curves is shown in Fig. 4. In this case, with a known total pressure at *C*, such as 60 psi, an appreciable portion of this pressure may be neutralized by the stiffness of the wood, or its natural resistance to bending, as at *A* and *B*. Assuming that it requires 10 lb of pressure to hold the veneer layers snugly against the mold at *A* and *B*, then $^1/_6$ of the total pressure at *C* is ineffective when applied at *A* and *B*, leaving 50 lb of "net effective" pressure at the ends of the veneer layers. While this example is a relatively simple one, there are numerous more complex situations, where the ratio of ineffective pressure to net effective pressure may be distinctly greater. Adequate allowances must always be made for this factor of ineffective pressure in forcing flat wood sheets or strips into curved layers.

VARIABLE THICKNESSES

It was pointed out earlier in this paper that flexibly molded plywood can be made in assemblies of varying thicknesses, and bonded together in one operation. Several examples are shown in Fig. 5. The upper sketch shows the overlaying of extra layers of veneer, which may be done on the bag side of the plywood as shown, or on the mold side, by providing suitable recesses therein. This might occur where reinforcement is needed as at the edge of a handhole, a door frame, or where extra strength is needed inside the leading edge of the wing near the fuselage. The center sketch, Fig. 5, shows a ring or aileron, prelaminated from parallel layers to the proper shape and recessed in the mold. Accurate dimensioning is imperative to keep the gluable surface of the ring exactly flush with the mold. If it is less than flush, the joint will be poor, and if it is too high, a ridge will show on the outside of the plywood. A more efficient method of attaching the rings or ailerons is shown in the lower sketch of Fig. 5, where the additional member is on the bag side, rather than recessed in the mold. These variable-thickness constructions can be adapted to the three major types of technique previously outlined in Fig. 3.

SUPPLEMENTARY METHODS OF APPLYING FLUID PRESSURE

In addition to the basic methods described, there are several more important supplementary processes that are typical of many other adaptations.

One of the simplest applications of fluid pressure is that shown in Fig. 6, where the flexible bag is a tube or a section of inflatable hose *F* and is laid in a rigid channel iron *H*. This channel iron takes the place of the semicylindrical shell *B*, in the upper sketch of Fig. 3, and restrains any effective pressure, except upward. The layers of veneer are forced against the wood mold *G* (Fig. 6) by inflating the hose *F*. This fluid pressure may be steam or hot water and should circulate through the hose to maintain uniform temperature, since the heat losses against the channel on three sides may be considerable. Either 2-ply or 3-ply Tego-bonded plywood can be used instead of single-ply veneer, but such multiple products would require steaming, prebending, and drying before assembly. This plywood angle clip is one of many types used for stiffeners, attachments, seat anchors, and the like in many types of plywood planes and

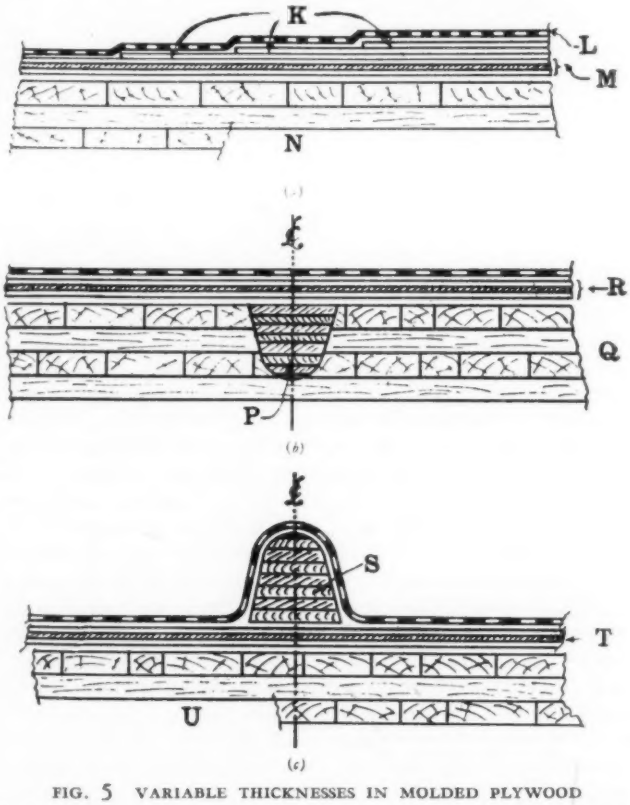


FIG. 5 VARIABLE THICKNESSES IN MOLDED PLYWOOD

(*a*, Overlayers of veneer for reinforcing; *b*, stiffening rings of laminated wood recessed in mold; *c*, stiffening rings on bag side of plywood.)

gliders. A number of other similar shapes are shown in Fig. 7, all of which can be made by this process. Such shapes can also be formed between pairs of heated metal dies, if the quantity is sufficient to justify the cost of the necessary equipment.

A different application of flexible tubular pressure can be made for secondary or assembly gluing, as is shown in Fig. 8, which is in contrast with primary gluing in the original flat or curved plywood. In this case, the problem is one of bonding a thin plywood skin covering to a series of curved ribs or stiffeners. A small cross section of one of the two-piece hinged clamps is shown in the lower part of Fig. 8, while a more detailed longitudinal section of a single joint is outlined in the upper part. The requirements of pressure are that it must be applied over a narrow area, but continuously around the entire periphery of the wing. Nailing strips, clamp pressure, or dead loading have all proved unsatisfactory. Nailing strips vary in intensity; nailing strips and clamp pressure have no "follow-up" and will gradually reduce; and dead pressure with weights or loadings is only effective in a vertical direction.

The fluid medium in such tubular-pressure applications is usually compressed air, since heat losses from the use of steam or hot water in such a small hose might be excessive. The thin metal strap *D*, Fig. 8, is used to distribute the pressure and to prevent the sagging of the skin covering between the ribs. A strip heater of the resistance type *C* supplies the required heat to cure the resin bond in the joint. The inflatable hose *B*, should be wholly deflated in the closed clamp, so that the area of tubular-pressure contact may be adequate. Only enough space should be allowed between the clamp member *A* and the plywood skin to provide for the insertion of the equipment indicated. The pressure to be applied will depend upon the stiffness of the ribs, but it should be as great as possible without damaging deflection on these supporting sections. Such assembly joints without tubular pressure have necessarily been made with a cold setting urea-formaldehyde-resin adhesive, and the clamping time was a matter of hours. With tubular pressure, it can be reduced to twenty or thirty minutes with the proper type of strip heater (16).

Another application of an inside flexible bag is shown in Fig. 9 where a complete plywood aileron can be molded against a pair of convex matrices. It is to be noted that this provides an outer streamlined surface, and that overlays of veneer may be used to provide a thicker section at the inside of the leading edge, as is shown in the upper sketch, Fig. 5. This will provide reinforcement for the concentrated stresses of attachment de-

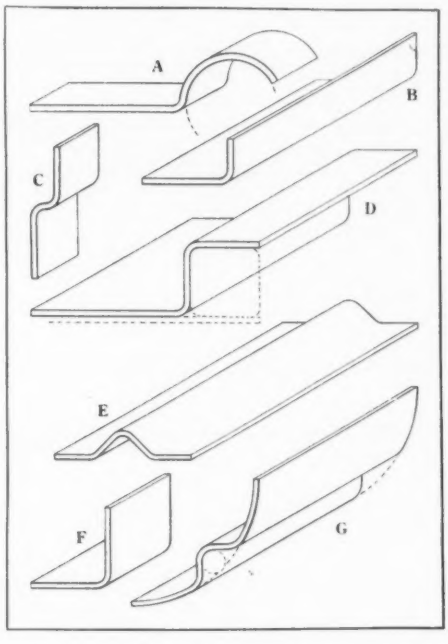


FIG. 7 MOLDED OR FORMED PLYWOOD CLIPS
(*A*, Flat plywood to metal tubing; *B*, *F*, angle clips; *C*, *D*, offset clips; *E*, stiffener; *G*, cylindrical surface to metal rod.)

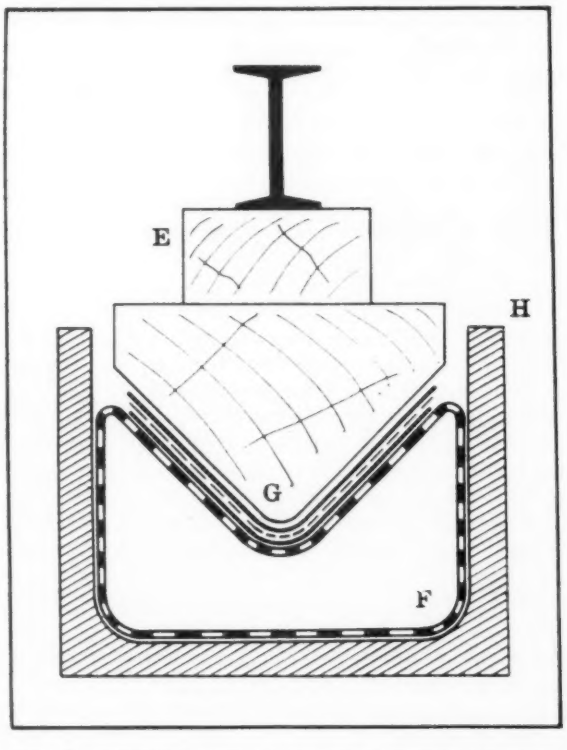


FIG. 6 MOLDING ANGLE CLIPS WITH FLEXIBLE TUBING
(*E*, spacer block; *F*, rubber hose; *G*, wood mold; *H*, steel channel.)

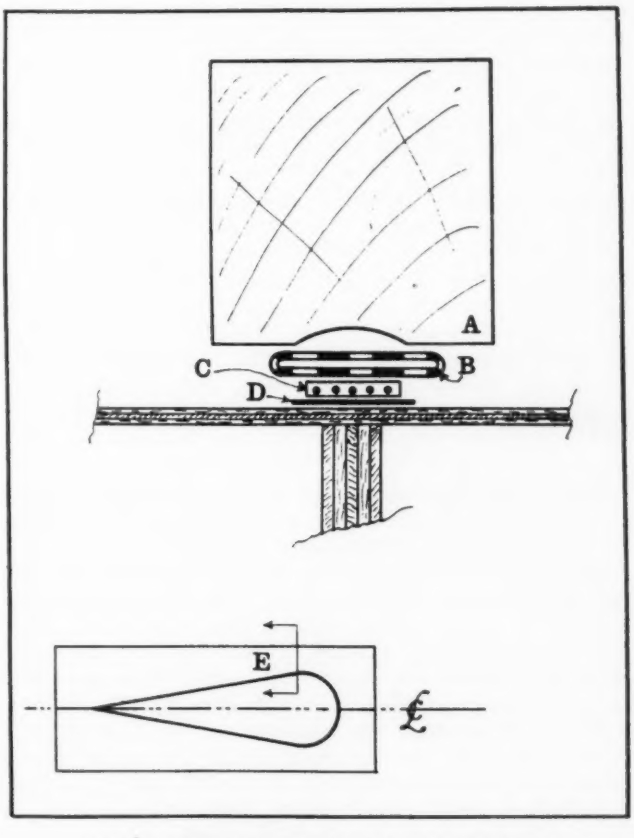


FIG. 8 TUBULAR PRESSURE IN ASSEMBLY GLUING
(*A*, upper half of 2-piece clamp; *B*, deflated hose; *C*, strip heater, resistance type; *D*, metal strap, to equalize pressure; *E*, smaller cross section of complete 2-piece clamp.)

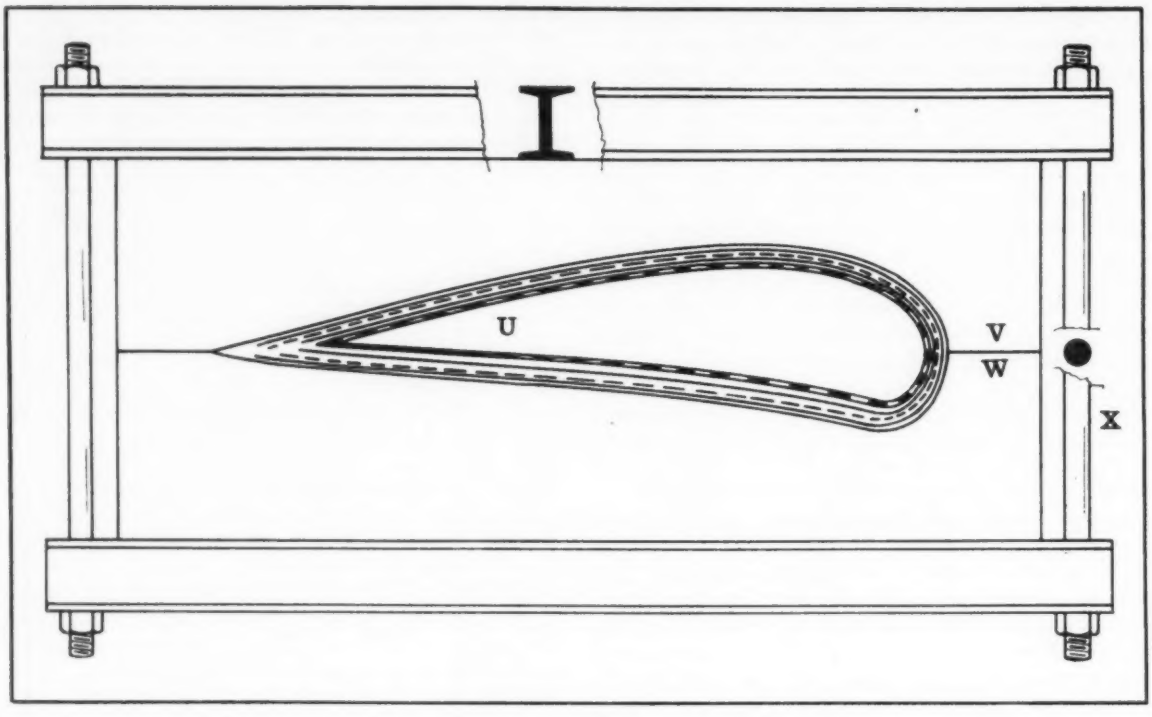


FIG. 9 AILERON MOLDED WITH INSIDE FLEXIBLE BAG

(*U*, Flexible bag, inside of plywood, which presses veneer against concave surfaces of matrices; *V*, *W*, recessed matrices; *X*, strain rods holding matrices firmly together.)

vices. The final joining of the trailing edge may be a subsequent bonding operation after machining the extremities into an accurate scarf. Such a construction can be made only with omnidirectional pressure, and a smooth streamlined exterior is imperative (20).

There are many other applications of pressure exerted by flexible bags and tubes in plywood production. They are found in both primary and secondary gluing. In general, the cost of bending flat plywood into simple curved shapes, where construction requirements permit, is considerably less than that of corresponding fully molded plywood. Such flat plywood, if bonded with a phenolic resin such as Tego film, can be steamed to soften and make it more ductile, then bent between forms or dies, and finally dried while firmly held in its curved shape. Some concentrated stresses may occur from the bending, but their significance can be anticipated. In the final analysis, monocoque and semimonocoque shapes can only be made by the molding processes, and, in this field, flexible-bag molding abundantly justifies its development. Many variants in this technique may be expected as experience widens this field.

MOLDS OR MATRICES

Most molds used in this flexible-bag process are of wood, plywood, or sheet metal, although some have been made of cast metal, plastics, and concrete.

The solid-wood mold is easily made of laminated and cross-laid lumber layers. It is relatively inexpensive but bulky and can easily be altered to accommodate changes in design. However, wood molds are wasteful in absorbing heat and require replacement from time to time. Some authorities consider 50 "cooks" an average expectation from a wood mold.

Plywood molds have the same exterior contour as the solid-wood mold, in fact they are usually made by reducing the size of the wood mold some $\frac{1}{2}$ to 1 in. in a direction everywhere perpendicular to the curved surface, and molding a thick plywood shell on the reduced mold. This shell may be used open, or it may be braced and enclosed as may be found necessary to support, rigidly, any pressure which may be applied. Such plywood-shell molds have the obvious advantage of being light in weight and tough, of providing long life, and of absorbing far less heat than the solid-wood molds.

In any mold of wood or plywood, the surface should be given a hard finish, both as a preservative and to prevent any adhesion of the inner layers of the molded plywood, due to the "squeeze-out" of the adhesive at the joints. Many users wrap the mold with a thin paper or cellophane to reduce this tendency.

A sheet-metal mold is shown in Fig. 3 (lower-right sketch), and its type of braced construction can be noted. Such molds are costly and only justified when the molded-plywood requirements are substantial. Design alterations are difficult to make in this type of mold. This thin metal mold, with stiffened edges, serves as one half of the rubber bag, and it must be airtight in order not to neutralize the vacuum. Since in this type of thin metal mold the heat of the autoclave is applied to both sides of the plywood, the bonding cycle can be considerably shorter in duration than when using solid-wood or plywood molds.

FLEXIBLE RUBBER BAGS FOR MOLDING

Satisfactory results have been obtained in the use of a fabric coated with a heat-resistant synthetic rubber, such as neoprene. The use of the fabric adds durability since the bag is employed for flexibility rather than extensibility. This is available in various thicknesses, but it is desirable to select as thin a sheeting as will withstand the hard service to which it will be subjected. Thin sheeting will also facilitate heat transfer through the rubber, and overlaps and folds will be less serious. Some authorities prefer the use of natural rubber, without a fabric base.

The sheet rubber is cut to size, folded, and cemented into the desired shape, either closed bag, open-end bag, or blanket. Any edges at the closure ends must be reinforced to permit folding over and clamping. Vent connections with valve stems require reinforcing and cementing in place, with suitable provision against sealing.

It has been found that rubber will deteriorate less under the application of steam alone than when exposed to a mixture of

steam and air which has an oxidizing effect. Steam alone under certain conditions may raise the temperature too rapidly before adequate pressure can be attained. Hence the relation of time, pressure, heat, and rubber durability require careful adjustment to an optimum compromise.

In many cases approximately 50 cooks are the normal expectancy in rubber bags, while some authorities claim to get 100. This limitation in rubber durability has directed attention to some type of airtight enclosure that can be discarded after use. Study is being given to some type of paper or flexible plastic which may be used only once. The present developments in this direction give promise of a better flexible-bag technique.

ADHESIVE REQUIREMENTS

There are several special features required of high-quality adhesives in bag molding. These are in addition to the normal requirements of extreme durability which are demanded in flat aircraft plywood. They are as follows:

1 The cure of the adhesive bond must be accomplished in a minimum of time, to permit economic and repeated cycles in the use of the mold, flexible bag, and autoclave. This from a practical viewpoint limits the adhesive to one of the synthetic types of thermosetting resins.

2 Low temperatures are highly desirable to permit as long a bag life as possible. Steam-heated autoclaves function best at 230 F and above.

3 Relatively long "flow" periods are important to allow slippage of every layer into final position during the pressure build-up and before final hardening. This can be accomplished by using a resin which remains plastic for a considerable period at 180 to 200 F and begins to harden at 220 to 230 F.

4 Long assembly times are imperative, since the wrapping of complicated molds may require a matter of hours, during which the adhesive must not be tacky. This suggests a phenolic or fortified urea resin that can be predried after spreading to remove the tackiness and can be softened again to a flow stage by the proper degree of heat.

5 Veneer to be curved should be as ductile as possible to eliminate rupture or excessive stresses in bending. The initial warping of single-spread surfaces should be reduced as far as possible. The use of part alcohol as a solvent will meet these requirements.

TYPES OF RESIN ADHESIVES AVAILABLE

Three types of thermosetting resin adhesives widely used in making molded plywood by the flexible-bag method are (*a*) phenol-formaldehyde-resin film such as Tego; (*b*) phenol-formaldehyde resin applied to the wood as a liquid; (*c*) fortified urea-formaldehyde resin also as a liquid application.

In the case of simple constructions, that can be assembled rapidly before surface-drying, low-temperature urea-formaldehyde resins are sometimes employed. Their cure without heat is too slow from a practical standpoint but it can be accelerated by heat at 100 to 150 F. In general, the durability and long assembly times of the phenolics make them preferable over the ureas wherever conditions permit their use.

The use of a Tego-resin film affords the simplest technique where the curvature is not so complex as to require much cutting or folding of the film. It is merely laid between the veneers, which should have a moisture content of approximately 5 to 12 per cent. The required temperature of cure is 280 to 300 F, and the relative length of the curing cycle is shown, for various types of molds, in Fig. 10. This chart is based on $^3/_{16}$-in. plywood and will require some adaptation for other thicknesses. In the use of Tego film, the amount of spread is uniform and any penetration of resin through the outer veneers is reduced to a minimum.

A liquid phenol-formaldehyde resin requires weighing, mixing, spreading, and predrying, as contrasted with the dimensioning and interlaying of film but is adapted to complicated and monocoque curvatures. Most of these phenolics are available in dry powder form with excellent storage stability and can be mixed with water or alcohol or combinations thereof. Alcohol-water solvents usually give the best results for flexible-bag molding. Double-spreading, on both surfaces of each joint is advisable and the amount of spread can be varied according to conditions. Predrying is necessary to avoid steam blisters during the cure cycle and to regulate flow and surface penetration. The cure of phenolic liquid resins can be accord-

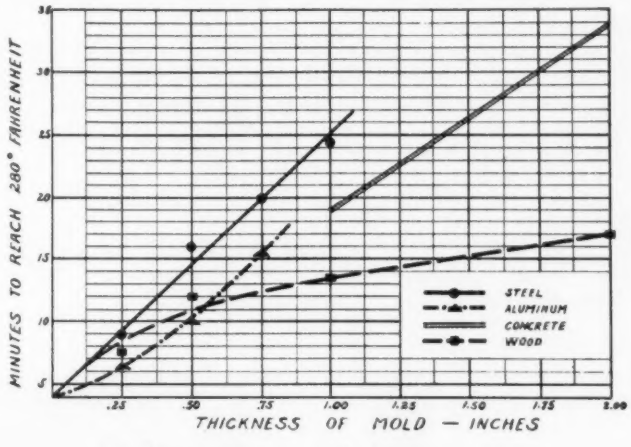


FIG. 10 TIME CHART FOR MOLDED PLYWOOD

(Time required to reach a glue-line temperature of 280 F on various types and thicknesses of molds, when making $^3/_{16}$-in. plywood. Courtesy of Duramold Corporation.)

ing to the graph in Fig. 10, if a temperature of 280 F is available. Many of the phenolics will also cure at 240 F, but under considerably longer cure cycles, which will vary with the mold types shown in Fig. 10. Some of the phenolic-resin adhesives of liquid types can be combined with special catalysts to bond at temperatures of approximately 180 to 200 F. Great care must be exercised in the selection of such catalysts, because of their effect on workable life, assembly time, flow characteristics, wood structure, etc.

The third option, as an adhesive for flexible-bag molding, is a fortified urea-formaldehyde resin. This requires special catalysts, which cause the ureas to approach some of the qualities of the phenolics. While the durability is appreciably less than the phenolics, it will permit long open-assembly times and will withstand limited boiling tests. Its temperatures of cure are lower than most phenolics, and time requirements are shorter. Its flow characteristics are better than the phenolics, under some conditions, but it cannot be used with alcohol solvents. On the other hand, the urea adhesives, due to the presence of catalysts, exhibit a gradual change in properties on the coated veneers, in contrast to the corresponding stability of the phenolics.

The present tendencies among leading bag molders seem to favor the phenolics, except for such applications as deep laminated rings, where heat penetration is slow.

CONCLUSIONS

Monocoque and semimonocoque plywood made by omnidirectional pressure is proving its adaptability in many aircraft and boat designs. The urgency of the war effort has not permitted the proper consideration of its utility for civilian products. Those who are most familiar with its possibilities feel that the war applications of such plywood are only the introduction to wider fields of usefulness for these unusual and efficient curved-plywood shapes. During the last ten years plywood has made tremendous strides, but the next decade holds even greater promise of plywood progress.

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TIRES NOW BEING BUILT BY WOMEN

(One of the women tire builders replacing men at a Fisk plant of United States Rubber Company lifts off the machine a tire which she has just built.)

The Relationship Between the UNIONS *and* ENGINEERS

By WILLIAM GOMBERG

DIRECTOR MANAGEMENT ENGINEERING DEPARTMENT, INTERNATIONAL LADIES' GARMENT WORKERS' UNION

IN discussing the subject of the unions' attitudes toward the industrial-engineering profession, may I make it clear at the very outset that I do not pretend to speak for the whole of organized labor. I have little patience with those who presume to make broad sweeping statements to which they attach the label of the entire labor movement.

It is true that broad statements made in the name of the entire labor movement often do reflect the actual attitudes of the majority of the unions involved. However, as a representative of a labor organization, I prefer to stress the fact that I am describing the policies of the International Ladies' Garment Workers' Union alone.

All of us must realize that the labor movement, considered as a whole, is not a thoroughly homogeneous entity and would not be even if power politics did not divide the A.F. of L. from the C.I.O. There is not only a wide disparity among unions, but within the subdivisions of the unions; and among the members of a single labor organization you will find wide variations in education, temperament, and work training.

The union must be viewed as a mirror for the mass opinion of its members, yet it possesses at the same time an institutional existence of its own which permits a much wider view of industry and its interests than would be afforded by any one single member. Each union has its own background, its own particular type of leadership, its own history, its own philosophical ideology, and each of these reflects itself in policies which vary from segment to segment within the entire body of the labor movement.

I mention the particular type of leadership as being one of those factors which prevent thorough homogeneity in the body of the movement. The public has recognized that the leadership of the International Ladies' Garment Workers' Union under President David Dubinsky is one of the more progressive and farsighted in the modern world of labor. Among our many national unions, the position which the International Ladies' Garment Workers' Union occupies is rather unique. Its importance as a force and influence transcends the relative position which the industry within which it functions occupies in the American economy. It has long served as a laboratory, a testing ground, for progressive collective-bargaining techniques which subsequently have been accepted and adopted by other unions and become standard practice. Hence, it may safely be assumed that many of the policies and practices formulated by the International Ladies' Garment Workers' Union will be the future practices and policies of other unions. Thus, you may readily understand why we in the I.L.G.W.U. in all modesty consider ourselves pioneers.

In fact, as early as 1916, when the labor and the scientific-management movements were at complete loggerheads, our international union, upon the suggestion of the late Supreme Court Justice, Louis Brandeis, and Morris Hillquit, invited one of the founders of the Taylor Society, R. G. Valentine, to conduct the first experiment in the application of the techniques of scientific management to the relationship between the union and management in the waist and blouse industry. Unfortunately, before Mr. Valentine's work could really get under way, he died, and the experiment was abandoned. In 1919, the first successful experiment in joint determination of work standards by labor and management utilizing the techniques of scientific management was begun in the Cleveland area and a full account of its progress can be obtained from Professor Slichter's book.[1] The experiment collapsed in 1931, but not until a substantial body of experience had been built up under the guidance of men such as Morris L. Cooke and Francis P. Goodell.

Presented at a meeting of the Management Division of the Metropolitan Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, N. Y., Jan. 14, 1943.

MANAGEMENT ENGINEERING DEPARTMENT, I.L.G.W.U.

The present management-engineering department of the International Ladies' Garment Workers' Union was organized two years ago to continue the tradition of labor-management co-operation fostered by the union's pioneers. In creating the management-engineering department, the Union listed its objectives as follows:

1 To assist in improving the manufacturing techniques and operating methods of all branches of the industry with which our workers' earnings are intimately bound. This will be done through plant inspections by department representatives, followed by specific recommendations.

2 To serve as a central information agency:

(*a*) To determine the level of "fair piece rates."

(*b*) To record the production system and manufacturing techniques under which these rates are paid.

(*c*) To assist in training shop members and committees in distinguishing bad time-study practices from good time-study practices in the determination of rates.

In order to fulfill these objectives, a motion- and time-study laboratory has been created with all the necessary equipment, including motion-picture cameras, projectors, wink counters, stop watches, and the like.

In addition, a standardized system of methods and techniques has been developed to cope with each situation as it presents itself.

The work of the department is divided roughly into two categories, i.e., long-term and short-term projects.

The long-term projects consist of building up a library of standard data for the labor operations in every branch of the ladies' garment industry. Eventually, the department hopes to develop standard formulas from these data which will give an ideal time for every type of manual operation in the industry.

Short-term projects have consisted of fulfilling requests for immediate field service in specific situations where the local union officials felt that the department could assist in overcoming stumbling blocks in negotiations and piece-rate settlements.

Where the department has been called upon to assist manufacturers to increase production, the problem of the department has been to steer a middle course between two extreme expectations:

1 The employer who believes that an engineer can come into his factory and revolutionize the plant within two

[1] "Union Policies and Industrial Management," by Sumner Slichter, Institute of Economics of The Brookings Institution, Publication 85, 1941.

weeks, increasing productivity at least one hundred per cent.

2 The employer who realizes that the installation of work-simplification methods is a long-term, expensive venture but expects the union's department to perform the actual installation of work-simplification methods and remain in the plant with a full-time staff until the installation is completed.

The method pursued by the department is to request the manufacturer to assign at least one member of his staff, and the union to assign one member of the shop committee, to work with the department's staff.

By means of process charts, the over-all production system of the shop is studied and analyzed. The manufacturer's representative and the shop-committee member are trained in the use of these charts. Likewise, individual operations are broken down, analyzed, and new and better methods are synthesized. Again, both persons are trained in the simpler techniques of these analysis methods. Thus the department simultaneously demonstrates the kind of improvements which may be expected and begins the training of the two individuals to perpetuate the work after the department's staff members leave.

When called upon to examine the basis of installations, time studies, or piece rates set by other engineering organizations or employer staff members, we request that our department staff member be accompanied by representatives of both sides. In this way, management becomes a party to the investigation and all data which we collect become unassailable. Copies of our reports are made available to the plant manager and local union manager exclusively to prevent the misuse of the information.

It is not the objective of the department to compete with private engineering firms endeavoring to operate in the industry. We do not make installations as they are commercially conceived. In fact, very often as a result of the initial taste which an employer has of these techniques, he is prompted to engage an outside organization to complete what we have started. It must be pointed out, however, that our industry is one of those rare groups still operating in the pattern of classic cutthroat competition. The number of employers who understand the implications of science as applied to the operation of their factories is still relatively small, and the heritage of bad management is still with us.

RELATIONS BETWEEN LABOR'S AND MANAGEMENT'S ENGINEERS

I should like to say frankly that the relationships between labor and management and between labor's engineers and management's engineers still leave something to be desired. At the present time, the International Ladies' Garment Workers' Union does not engage in these activities because it is convinced, by the argument offered in work-simplification training programs, that without greater production you cannot secure a real increase in wages, thereby leading the workers to conclude that increased production will necessarily lead to increased earnings under our present economic setup. The proposition is valid enough; the conclusion does not necessarily follow, and it is this assumption of the conclusion which is at the root of much of the misunderstanding between the unions and the industrial engineers.

I have referred to the lack of homogeneity in the body of the labor movement. Therefore, you see, the attitude of the union toward industrial engineers and their work does not follow any fixed pattern, nor does it reflect a consistent policy. The policy itself, I do not hesitate to say, is in a constant state of flux and is shaped to a large extent by the dynamics of our economic society, the personalities and social intelligence of the engineers themselves, and, I might add, the social intelligence of the union officials.

The Pittsburgh steel industry deals with a labor leadership which is perhaps further advanced than many others of the new union leaderships with which management must deal. Clinton Golden who is in charge of the Pittsburgh district of the United Steel Workers is a progressive and is fully cognizant of the implications and economic significance of the work of the industrial engineers. In fact, he was invited by the Society for the Advancement of Management to address its annual meeting upon the very subject which we are treating here. Because of the type of labor leadership in this district, it would seem that the Pittsburgh steel-industry engineers would be in a position to work under far more favorable conditions and in a far more favorable atmosphere than in many other situations, but what is the attitude of the steelworkers toward them? Permit me to quote from an article which appeared in *Fortune* for November, 1942. The article was entitled, "What's Itching Labor."

> In general, Pittsburgh workers have a distinct set of likes and dislikes. Most popular with them are, in this order: The United States of America, Franklin D. Roosevelt, the unions, and the United States Army. Least popular, in this order: The Japs, the Nazis, and the "industrial engineers," followed closely by the "dollar-a-year men."

BARRIERS BETWEEN ENGINEERS AND LABOR

What are the barriers between the engineers and labor which prevent understanding and co-operation? These barriers can be classified into two categories: (1) The technical, involving rate setting, the design of wage incentives, etc., and (2) barriers of our social environment.

The principal technical barrier, of course, as you can readily understand, is the shortcoming of the time study itself. It is not my objective to deny the usefulness of the time study but to point out the limitations of its accuracy. Thus far, no alternative method of measuring or estimating a reasonable day's work has appeared. Hence, the time study must stand until a better technique is found. Unions which denounce time study and refuse any participation in its use must either furnish a superior alternative method of measurement of a day's work or appear completely irresponsible.

Acceptance of time study, however, does not mean acceptance of all the claims of its partisans, practitioners, users, and abusers. The profession, unfortunately, has failed to police itself. It has been content to denounce malpractice in general. It has not, to my knowledge, denounced any malpractitioners. In fact, point 5 of the Code of Ethics for Time and Motion Study Engineers, adopted at the 1940 National Time and Motion Study Clinic of the Industrial Management Society, states: "Give credit where due and refrain from disparaging the work of others." Adherence to point 5 may make for pleasant social gatherings at our professional meetings but seriously opens the profession to public suspicion.

However, let us assume that the profession has cleansed itself of the conscious malpractitioners. Can we then say that all internal barriers to a complete understanding between the engineers and labor have been broken down? Let us examine the present state of the time-study art. Time study was represented by its advocates in 1911 as ". . . accurate and scientific. It makes careful studies of fatigue . . . adding due and scientific allowances for the human factor and legitimate delays." At least, this was their verbatim statement to Prof. R. F. Hoxie who was investigating the scientific-management movement for a congressional committee.

Hoxie's evaluation of this claim was predicated upon the following criterion: "If a method of analysis is scientific, the judgment of the time-study man must not enter into the process of its determination in such a way as to affect the fact itself . . . His function must be purely that of discovery, for if he can at any point in the process alter his judgment in such a way as to alter the outcome, it becomes a variable for each observer."

Hoxie then went on to list seventeen variables which influence the time study. These variables may be broken down into six classes, aside from the personality and ability of the observer

himself. As I list these six classes, I should like you to ask yourselves these two questions:

1 How much progress has the profession made in reducing this variable to uniform treatment?

2 To what extent does the factor of human judgment still influence the measurement of the variables listed?

The variables are:

1 The extent to which the working method has been simplified and standardized before the time study is taken.

2 The method of measuring and recording the raw data.

3 The particular statistic derived from the raw data as a measure of its typical or expected value.

4 The allowances for personal needs, rhythm variation, and fatigue.

5 The method of reducing the time-study data to normal data.

6 The allowances added for down-time, setup time, and clean-away.

After a careful search of the literature, I can find a material improvement since Gilbreth's time in the treatment of only one category, category 6, the allowances for down-time. I am referring to a paper by Mr. Morrow[2] on ratio-delay studies. Mr. Morrow actually developed a statistically valid technique based upon the original researches of L. H. C. Tippett in the English textile industry.

Unfortunately, altogether too many other papers have either been old hash, garnished with platitudes, or, if we are charitable, we can call them reorganizations or representations of old knowledge. Please note that I am confining my remarks on this score to time study and not to motion study.

I should like to call attention to the data of Tables 1 and 2, consisting of a page from the time-study manual of a leading consulting firm operating within our industry.

Table 1 is an analysis based upon adding up the times for all elements. The arithmetic mean is taken of all the totals, 0.71; the minimum time is 0.70; the two are averaged and the selected minimum of 0.705 is finally derived.

TABLE 1 OVER-ALL TIMING METHOD

	Observations														
Complete cycle.....	1	2	3	4	5	6	7	8	9	10	Average	Minimum	Selected minimum	Leveling factor	Adjusted TST
All elements.....	72	70	70	73	72	70	71	70	72	70	0.71	0.70	0.705	0.70	0.494

TABLE 2 ELEMENTAL TIMING METHOD

	Observations														
	1	2	3	4	5	6	7	8	9	10	Average	Minimum	Selected minimum	Leveling factor	Adjusted TST
Element A.....	4	6	8	4	10	5	8	14	5	6	0.07	0.04	0.055	..	...
Element B.....	40	20	18	20	30	18	37	19	37	31	0.27	0.18	0.225	..	...
Element C.....	12	8	6	10	14	6	8	7	13	6	0.09	0.06	0.075	..	...
Element D.....	10	28	24	22	10	26	10	16	10	14	0.17	0.10	0.135	..	...
Element E.....	6	8	14	17	8	15	8	14	7	13	0.11	0.06	0.085	..	...
TOTALS.....											0.71	0.44	0.575	0.70	0.403

Reviewing these tabulations, it is observed that if only total cycle times had been recorded, a minimum of 0.70 min would have resulted, which is 82 per cent higher than the minimum time of 0.44 min recorded for the cycle under the second method. While the selected minimum time for the synthetic cycle of elements was 0.575 min, the selected minimum obtained by the over-all timing method would be over 22 per cent higher at 0.705 min. *From this it may be seen that the fundamental principle of time-study work, namely, the timing of the small elements of the cycle separately and then constructing a new synthetic cycle on the basis of selected minimum times, must never be departed from. . . .* (Italics, author's.)

MISAPPLICATION OF TIME-STUDY PRINCIPLES

The first question I should like to ask is: On what basis of sampling theory is this selected minimum arrived at? The only statistic which we can subject to sampling tests is the arithmetic mean. What makes a selected minimum more typical of expected performance than the average value? We do know from the law of large numbers that

$$P\,[(M - Exc) > a] < \frac{\sigma^2}{na^2}$$

in which

P = probability
M = mean
Exc = a priori expectation
σ^2 = variance
n = number of readings
a = any preassigned number

In other words, as our readings increase, the typical or expected value will come closer to the mean. It is on this basis that I use the arithmetic mean. But, for the sake of argument, let us grant the validity of the selected minimum and proceed with our analysis.

You will note that the firm goes on to take the average of each element, its minimum, secure an element selected minimum which when added gives us 0.44 instead of 0.70. Certainly an ingenious procedure. Of course, the conclusion of the firm which you can read in the author's own words is that this discrepancy constitutes the argument for element timing or against over-all timing. Now, I'm all for element timing, myself, but what sort of logic is this? I am for element timing but not because you can chisel a minimum down 82 per cent.

Examine the readings themselves. You will note variations of as much as 300 per cent among the readings of Element A, 100 per cent in Element B, etc. This time study indicates one of two things: Either the job was not standardized and not ready for time study, or else the observer failed to demark his end points accurately. Can you imagine the kind of havoc that illustrative examples like this can cause in a factory when the neophyte engineer takes this material seriously?

There is good reason for element timing, but certainly not the reasons set forth here. Of course, it may be argued that this base figure is to be adjusted by allowances, but how accurate can we expect these intangibles to be when observed data are treated so haphazardly?

In fact, the wide variation between element times raises the whole question of the accuracy of the stop-watch observation. Permit me to describe an experiment conducted by Mr. Lenge at the industrial-engineering laboratories of New York University. The data are his, but I should be held solely responsible for the conclusions derived.

[2] "Ratio Delay Study," by R. L. Morrow, Trans. A.S.M.E., Miscellaneous paper no. 6, presented at Annual Meeting, Dec., 1940; abstracted, MECHANICAL ENGINEERING, vol. 63, 1941, pp. 302–303.

A calibrated synchronous motor drove an endless loop of film. Various frames were covered with pasters to denote time lapses as the frames by-passed a fixed pointer. Stop-watch readings were recorded of the operation by nine observers whose time-study experience varied from six months to ten years. These observers were selected by Mr. Morrow, of the New York University engineering faculty as competent practitioners. Each individual took twenty stop-watch readings. The observations were tested for significant differences between the men, and they were found to constitute a reasonably homogeneous group. Since we took twenty readings for each man for each element, we should have secured a total of one hundred eighty readings. However, because of accidental interruptions, we sometimes secured slightly less than this number.

TABLE 3 RESULTS OF COMBINING READINGS OF THREE ELEMENTS

N	A	B	C	D	E
172	6.25	6.045	0.926	15.3	45.9
163	2.50	2.816	0.836	29.7	89.1
164	8.75	8.366	1.293	15.4	46.2

NOTE:
Column A represents the known time lapse from the synchronous motor.
Column B: The arithmetic mean.
Column C: The standard deviation.
Column D: Column C over Column B, or the coefficient of variation.
Column E: Three times the coefficient of variation.
Column N: The number of readings.

It will be noted that, although the means do not differ more than 3 to 5 per cent from the "true readings" in the case of the elements measuring 6.25 and 8.75 min, respectively, in the case of the 2.50-min element, the deviation is in the neighborhood of 13 per cent, indicating the complete breakdown of the watch as a measuring instrument in this region. Columns D and E, respectively, at the 67 per cent and 99.7 per cent probability point show very wide variation coefficients which indicate the intense danger of attempting to use element minimum readings. We do not know whether we are reading a stop-watch deviation or an actual performance minimum. Furthermore, these are laboratory conditions, superior in accuracy to shop conditions. Can you imagine what happens in the shop?

Another interesting side observation is the variation of human performances among the observers themselves. How much of the deviation is the deviation of the observer rather than of the observed?

CONFUSED TIME-STUDY PRACTICES

What is the reaction of a union engineer to be then when he is confronted by a nationally known consultant who assures him that it is possible to measure the time that it should take a skilled person to perform elementary motions to an implied accuracy of one one hundred thousandth of a minute? Yet I have a manual in my possession which gives figures to such an accuracy and expects us to respect synthetic standards built on these figures. If at least the methods by which these figures were obtained were published, we could weigh them intelligently, but this professional knowledge is treated as a business secret. Arguments to the effect that standards, set by the consultant to whose manual I am referring, have worked are hardly an answer to this professional obligation. The whole question of how we are to measure the effectiveness of a standard would have to be opened, a line of departure which I am not prepared to take at this time.

The wide variations among practitioners in assigning leveling factors, fatigue and other allowances, added to what I have already pointed out, gives us indeed a confused picture.

Just what are we allowing for when we assign a fatigue allowance? After years of study, the Industrial Fatigue Research Board of Great Britain could not even define fatigue, much less measure it. Prof. Elton Mayo[3] and R. S. Uhrbrock[4] both discuss this problem at some length. In fact, Mayo, in discussing the results of the Hawthorne experiment and the work of the British Fatigue Research Board, indicates what a psychological variable the whole fatigue concept is and the difficulty of measuring it. Further study will perhaps eventually solve the problem, but it is a bit presumptuous for us to pretend in 1943 that we have an "accurate, scientific method of computing allowances." The truth of the matter is that we are working under severe limitations of knowledge. Hence we cannot eliminate bargaining in the determination of rates, we can but reduce the range within rational limits.

However, none of these technical barriers present difficulties which cannot be overcome by joint study and research. I believe that an engineering body such as The American Society of Mechanical Engineers might take the initiative in co-operation with some leading university in setting up joint research programs for fuller investigation of these techniques. It would be wise to secure participation from engineers working both in management and with labor so that points of view might be compared and differences resolved. There are no immediate and easy solutions. If Taylor and his associates took twenty years just to find out what the best feeds and speeds for operating machine tools are, we should hardly expect to reduce a human being to as careful an analysis in less time.

LEVELING THE BARRIERS OF SOCIAL ENVIRONMENT

We now proceed from the technical barriers to the barriers of our social environment. However, before we investigate the nature of these social barriers, let us consider the possibilities which union-management co-operation promises for society under the ideal environment. The closest we have come to this ideal environment, strangely enough, is under the stress of the war situation before inflation began to assert itself.

Specifically, I mean by an "ideal" environment that the worker must be convinced that long-term unemployment presents no hazards to him because he is living in a perpetually expanding economy. Any temporary dislocation caused by technological change would be cushioned by an advanced social-security system plus an additional retraining program. He must believe that increases in production actually mean proportionate decreases in prices; that the price structure of our economy is completely rational rather than restrained by the imperfect laws of oliogopoly. I do not mean that prices must necessarily be controlled by competition. They can as well be set by properly engineered social controls. The workers must feel that they are citizens of an industrial community and are actually consulted in all matters affecting their welfare. To be more specific, I want to destroy a concept of trade unions widely held and first described by Frederick Taylor. When Taylor was asked why he objected to unions, according to his biographer, Copley, he rather bitterly replied that where workers were up against a hog employer he was all for the union, but where the factory was governed by the laws of scientific management, the union ceased to have a real function and was unnecessary.

When I say that the worker must feel himself a part of an industrial community, I mean he must feel that he is part of the productive process, that he is using his union as something more than a policeman, using it as a vehicle of democratic participation in industrial life. I could draw an analogy by asking the following question: Would you be satisfied to be ruled

[3] "Human Problems of an Industrial Civilization," by Elton Mayo, The Macmillan Company, New York, N. Y., 1933.

[4] "A Psychologist Looks at Wage Incentive Methods," by R. S. Uhrbrock, American Management Association, Institution of Management Series No. 15, 1935, pp. 3–28.

by a beneficent despot who was sincerely concerned for your interests but who would permit you no voice in your government? The worker feels completely the same way about the beneficent oriental despotisms which made up the workshops of America in 1929. Unions, in short, if they are to perform their functions must be more than purely wage-and-hour organizations; they must be vehicles for the workers' participation in the administration of industrial government.

As a substitute for these ideal circumstances, we are confronted with a war which at least temporarily tables them and gives free play, with plenty of limitations, to the realization of some of these possibilities.

The question of whether or not we can set up participation in pluralistic management is no longer in dispute. We have progressed a long way from the old, crude, unorganized suggestion systems upon which we had to rely before 1923. I do not know whether the creators of the industrial-engineering techniques, which I will cite, realized the tremendous implications to the extension of democracy contained within those techniques. I refer to the industrial-training program first organized in 1923 by Lillian Gilbreth and brought into full flower by the researches of Professor Barnes of Iowa, the teachings of Prof. David Porter of New York University, and the evangelical activities of Allan Mogensen on behalf of the work-simplification movement. The fundamental distinction between their methods and the ones used before was the essential change in concept of functions of the industrial engineer. Whereas previously, the industrial-engineering movement relied completely upon a military form of organization in which the engineer in charge gave all the orders and the workers were unthinking "hands," adequately paid of course, the work-simplification program tacitly implied that plenty of brains existed among the workers and that if the engineer spent time in training these workers along specific lines, he would secure immeasurably more from his work than if he were to try to do all the work improvement in the factory himself. In other words, the engineer became a teacher.

Of the many tools devised for workers' participation in management, I believe that this technique has more technical possibilities than any I know. Note that I say "technical possibilities," because as the work-simplification group has recognized, the principal problem is one of overcoming the suspicions and inhibitions of the workers themselves. I have the highest respect for the technical achievements of the group but seriously question the pseudo economics with which they attempt to break down workers' inhibitions. As I have pointed out, the war has suspended many of these economic barriers, at least temporarily. Lest I be misunderstood, may I say that the work-simplification group was successful in many instances in overcoming the inhibitions of workers before the war, but purely in isolated cases.

The activities of those few management-labor councils set up by the War Production Board which are really functioning have more than justified themselves. Many others, of course, are merely paper committees, but those few which have succeeded certainly indicate the possibilities inherent in the technique itself. Too many of the committees have existed on paper alone because frankly we have found that management's willingness to show off its management techniques varies directly with the competence of the management itself. Altogether too many "secrets" have turned out to be mere smokescreens concealing managerial incompetence. For this reason, we are suspicious of managers who voice fears that management-labor committees invade the proper jurisdiction of management alone.

Will the fate of these committees, set up during this war, be the same as those committees started during the last war? The National Industrial Conference Board, after the same sort of public hullabaloo had been made during the last war, published a tract in 1922 called, "Experience With Work Councils in the U. S." One of the statements made in this report was: "Most of the shop committees established by the War Labor Board have ceased to function." I think we will find the answer to the question I have posed in a re-examination of those barriers of the social environment which I have mentioned as separating the engineers and the unions.

THE WORKER AS A HUMAN BEING

Let us examine the worker as a human being and see with what he is confronted when he sets out to earn his wage. The industrial engineer informs him that he is to be paid in accordance with what he produces. That sounds reasonable. But then he looks around at the things he must buy. Is the price structure built in strict accordance with value received? No, of course not. The economically fair laws are all circumscribed and circumvented, and he discovers that in reality the price of an article is largely determined by what the traffic will bear. Well, why so much concern about mathematical exactitude with regards to wages? Why should he be any less predatory in his labor market than his employer is in the commodity market?

The next things he is told are those elementary economic axioms found in work-simplification programs, i.e., he must produce more and more and more. And then he reads in the morning paper of how millions of oranges are left to rot or dumped into the sea to maintain an artificially high price for the producer. Something is evidently wrong. Is the objective of the engineer maximum production or something else? Is there a dichotomy between maximum production and maximum profit? In the introduction to a book[5] by C. E. Knoeppel, ex-secretary of the Society of Industrial Engineers, published in 1933, we read the following: "If we are to continue a nation of solvent business people . . . . we must make *profits* rather than *volume* our goal." (Italics, the author's.) In fact, citing some of the work which he had undertaken, Mr. Knoeppel points out that a radical change in approach was necessary. "Instead of working from the standpoint of organization and production, the viewpoints became those of sales, finance, and profits."

Now, very naturally, just as a firm may find under our present method of doing things that there is not necessarily a direct relationship between maximum profit and maximum volume, a worker may soon likewise discover that there is no direct correlation between his maximum effort and his maximum yearly income. Yes, he might make more an hour temporarily and work himself out of a job. Is this point of view confined to the organized workers? I refer to an excellent study made under the auspices of Antioch College by Stanley Mathewson,[6] Secretary to the Ohio Chamber of Commerce.

All of us recognize these defects in our society but like to point back to some statistic to show the amount of work produced by a new invention. The dispute over the division of the increment of technological progress has been confused by lumping all kinds of technological progress under one general heading. There is no dispute on the score that the invention of a new product which does not replace some old product but which, like the radio, relies upon the creation of an entirely new type of demand, will increase employment. The division of the increment from other types of technological progress which rely upon a decrease in the number of labor-hours required to produce a unit of production is not so easily analyzed. In fact, the institutional frictions of our economic order have been so severe during the last one and one-half decades that, as late as the beginning of 1940, the estimated amount of unemployment varied between $8\frac{1}{2}$ and 12 million, the former a

[5] "Profit Engineering," by C. E. Knoeppel, McGraw-Hill Book Company, Inc., New York, N. Y., 1933.

[6] "Restrictions of Output Among Unorganized Workers," by S. B. Mathewson, Viking Press, New York, N. Y., 1931.

National Industrial Conference Board estimate, and the latter a C.I.O. estimate. This was at the same time that we had reached the 1929 level of output. Of course, it may be argued that the 1929 level did not constitute a ceiling. We do know, however, that between 1919 and 1929, although the population grew substantially, the number of wage earners and manufacturers remained almost stationary despite a 50 per cent increase in output. If we compare this with England's experience, we would seem to have been well on the way to reconciling ourselves to a permanent army of unemployed.

It is a little silly to expect unions to be concerned about minute wastes of potential productivity when the country had all but resigned itself to this prodigious waste of manpower.

What is actually the state of mind of the worker today? Of course we all realize that under the impetus of the war effort, the average worker is giving us today more production than he would ordinarily give under peacetime conditions when he figures that he is working solely for a private employer who will use every possible means to get the most possible work from him at the lowest market price. In 1941, the Psychological Corporation conducted a poll of public opinion. One of the questions asked was, "When this war is over, do you think that the people of this country will be better or worse off than they are now?" Of the people interviewed, 13 per cent thought they would be better off, 69 per cent thought they would be worse off, and 18 per cent had no opinion. Another question asked was, "How about jobs, will there be more, fewer, about the same?" and on this question, 8 per cent thought more, 74 per cent thought fewer, 11 per cent about the same, and 7 per cent had no opinion.

What has been done to allay this fear of the worker? Unless his mind is changed, as Roethlisberger and Elton Mayo of Harvard have pointed out in their studies of the Hawthorne experiment, production may fall to catastrophically low levels. The worker's state of mind far transcends in importance any other of the working conditions which the engineers could provide for him, such as rest periods, lighting, and other similar considerations.

During the last war, a large proportion of business management was perfectly content to permit President Wilson to enunciate his high idealistic objectives while we were at war. There would be time enough following the war for cooler heads to return us to normalcy. In this war, they have become more bold. Vice-President Wallace cannot get away with a statement of objectives without an immediate and violent reaction. Proposals for the extension of the Social Security system and attempts to improve national planning are greeted with a cold, calculating cynicism which reflects itself in remarks about not feeding Hottentots, etc. The justification for this cynicism is based upon the contention that all too few people realize that our present production miracle is made possible by the existence of a free-enterprise system.

HAVE WE PERFORMED A "PRODUCTION MIRACLE?"

I doubt that anyone knows the extent to which we have performed a production miracle. Complete figures must, of course, remain a secret at this time. The Tolan Committee,[7] has indicated that, at best, we have simply been taking advantage of our "unorganized might" and have nowhere near approached our productive possibilities.

We will not be able to measure what we have done until this war is over. We do know that the same kind of hullabaloo about production was made during the last war and was followed by some rather unpleasant disclosures:

"Even a superficial view of what took place, during 1918, reveals the fact that our efforts at production were sadly ineffective. So true is this that some of those in authority not only discouraged all efforts to show comparison between their promises and their performances in such a manner that the public could understand, but they actually forbade such comparisons to be made . . . The reasons for its falling short are undoubtedly that the men directing it had been trained in a business system operated for profit and did not understand one operated solely for production." The man who made these observations was Henry Gantt, a founder of scientific management and certainly one who was in a position to know.

Gantt very early realized that management does not imply a homogeneous entity. There are managers of production, managers of distribution and finance. In the present setup, it is usually the general manager of distribution and finance who is in a position to dictate a program to the managers of production. I have infinite confidence in the ability of managers of production. The managers of distribution and finance have given us all an adequate picture of their own incompetence, and it is in rather bad taste, I think, for them to spring up now and claim credit for production miracles.

I have been dwelling on these policies at some length because they seem to represent a good part of the leading industrial opinion of this country and will shape the world in which the engineer will have to work tomorrow. As I have pointed out, the Psychological poll shows a tremendous fear among workers of a catastrophe following the war, yet there is a widespread demand for postponement of amendments to the Social Security Act until after the war when the catastrophe will be upon us. Fortunately, there are a few voices among management which recognize the problem.

Percy Browne, president of the Society for the Advancement of Management, in addressing that society, commented on the fact that, when our free-enterprise system was operating at its very highest level, millions of Americans bought autos and electrical gadgets, while, at the same time, probably not more than one third of our American children had to go without milk and medical care. And I might add these children were not Hottentots. A great many of them probably lived on the Mississippi, not the Danube. It was Mr. Browne's implication that no matter how much our revered American forefathers may have believed in free enterprise, they would not have gone in heavily for the production of luxuries while a third of the family went without shelter. "It seems to me that we can evade responsibility no longer, for one of these days, and I don't know when, we are going to win this war and after that, we will either have some form of industrial co-ordination to achieve general prosperity by competent planning or we shall again revert to industrial aimlessness."

I know no one who is against postwar planning. Like liberty, everyone is for it because it means different things to different people. Mr. Browne's meaning is quite clear. His plan would start with how to increase and distribute purchasing power and not merely cater to an existing maldistribution, such as seems to be the general approach of most business postwar planning. Engineers operating in this postwar world will not be able to be apolitical. They will either be politicians on their own or political victims. The choice is theirs.

When the engineers attempt to exercise their functions in society in the future, they will naturally be challenged for an account of their trusteeship. If the cynical philosophy which I have cited dominates the scene, the engineers will of necessity be responsible to irresponsible employers and the conflict between the unions and the engineers will increase in bitterness.

If the prevailing forces of society are the progressive managers, the progressive unions and the engineers will be able to maintain a professional concept of trusteeship, and, although friction will develop occasionally, there is no reason to believe that the engineers and the unions cannot look forward to a fruitful period of co-operation.

[7] *New York Times*, Jan. 11, 1943.

MARINE-DIESEL AUXILIARIES

Brief Discussion of Some Typical Installation Problems

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PERHAPS one of the most common problems confronting the builder of the generator type of Diesel engine is that of the exhaust system. Having given adequate attention to the exhaust system of the main engines and arranged to get the most direct path possible between the exhaust outlet and the stack, a common and easily explained practice is to pay a great deal less attention to where the auxiliary engines may be placed, with the result that the exhaust line is frequently extremely long and of a tortuous nature. High back pressures usually result, and, in a number of cases to our knowledge, it has been necessary to make rather radical changes in the exhaust system, to lower the back pressure sufficiently to permit the auxiliary engines to pull the required overload.

Being builders of both 4-cycle and 2-cycle engines, we fully appreciate that this problem is quite different on the two types of engines, the 2-cycle being the more sensitive and requiring larger exhaust lines. However, a very large percentage of the generator engines being installed under present conditions is 4-cycle, and we will therefore limit our discussion to that type when considering the exhaust system.

Various engine builders have undoubtedly had many different experiences with exhaust systems and probably have developed radically different ideas concerning the practical point at which to stop in permitting back pressure. The amount of back pressure which can be tolerated of course depends upon a number of factors including valve timing, size and number of valves, engine rating in brake mean effective pressure, and speed, as well as whether or not the engine is supercharged. It can easily be shown that the modern, well-designed engine, even of the supercharged type, can be made to pull over 100 bmep with a back pressure of 100 in. of water. However, when so doing, exhaust temperatures are materially increased, and the engine is therefore permanently punished unduly, while more consideration of the initial installation would have prevented it. For an engine rated so that its overload capacity requires it to go to 100 to 105 bmep atmospheric, or up to 130 to 135 bmep supercharged, it is therefore recommended that the back pressure be held to a maximum of 30 in. of water.

While in most cases the intake air is taken from the engine room, there are instances where it is piped from the outside; in others intake silencers are applied. Both of these tend to cause a pressure drop in the intake line. While again it can be shown that higher intake drops can be permitted under certain circumstances, it is recommended that the vacuum be limited to 10 in. of water.

Calculating Pressure Drops

It would be a logical question, on the part of shipyards in particular, how these pressure drops could be calculated from known systems of piping. It is desirable that they be thus calculated without delays of submitting piping systems to the engine builder for calculations. The following formulas have been proved over years of use and can be relied upon:

$$\text{For exhaust, } H = (W^2 \times L)/(10{,}000 \times d^{5.33})$$

$$\text{For intake, } H = (W^2 \times L)/(25{,}000 \times d^{5.33})$$

in which W = lb per hr of air, or gas; L = equivalent length of pipe, ft; d = inside diameter of pipe, in.

To calculate the equivalent length of pipe: 90-deg standard ell = 15 diam; 90-deg tube-turn ell = 10 diam; 45-deg standard ell = 6.4 diam

In the foregoing, temperature of the exhaust gas has been assumed to be 800 F, while that of intake air is 100 F. Reasonable variations from these conditions need not be considered.

In many cases, it is necessary to convert one diameter into an equivalent length of another diameter, when one or more diameters of pipe are connected into the same system. To make this conversion, we use the following formula

$$L = (d^{5.33}/d_1) \times L_1$$

in which L and d are the length and diameters, respectively, of the reference pipe size being used in the calculation of the pressure loss, while L_1 and d_1 are length and diameter, respectively, of a size of pipe being converted to the reference size. The point of measurement of back pressure should be immediately outside the intake or exhaust manifold, and through a connection normal to the flow of gas. It is realized that, in many cases, time may be saved if the designer is not called upon to determine log functions, therefore for convenience Table 1 is presented.

TABLE 1 PIPE DETAILS

Nominal pipe diameter, in.	Actual inside diameter, in.	$d^{5.33}$
2	2.067	47.9
2 1/2	2.469	123.9
3	3.068	393.6
4	4.026	1690.0
5	5.047	5623.0
6	6.065	14960.0
8	8.071	68860.0
10	10.192	237100.0
12	12.090	584800.0

No attempt is made in this table to take into account the phenomenon of pressure waves in exhaust lines. These waves seldom appear in sufficient intensity to affect 4-cycle engines but must be taken into account when applying 2-cycle units. In the latter case, the accuracy of calculations of pipe length to avoid waves which interfere with scavenging is doubted, and it is therefore recommended that experimental data be secured from the engine builder.

Pump Applications

Water-circulating systems probably deserve some mention. Due largely to the reversing engine requiring some form of circulating pumps which are not subject to direction of rotation, plunger pumps are still frequently called for, even on auxiliary engines. As the speeds of such engines have been greatly

Presented at a Symposium on Marine Power under the joint auspices of The Society of Naval Architects and Marine Engineers and the A.S.M.E. Power, and Oil and Gas Power Divisions, at the Annual Meeting, New York, N. Y., Nov. 30–Dec. 4, 1942, of The American Society of Mechanical Engineers.

increased, plunger pumps have become more and more difficult to apply. It is recommended that centrifugal pumps be considered in all possible cases.

Since indirect cooling is almost standard practice now, the centrifugal pump can still be used for circulation, even if the engine is above the water line, provided some other means is available for circulating salt water. Quite frequently, we supply the engines with double centrifugal pumps, one for fresh water, and one for salt water, and this is entirely practical if the engine is below the water line.

However in the application of centrifugal pumps, we still find a general tendency to disregard their characteristics with reference to head and capacity. The characteristics of the individual pumps must be taken into account, as we quite frequently experience cases in which, because of a complicated piping system, the pressure head is so great that the pump delivers practically no water at all. The engine builder can standardize on a centrifugal pump for circulating fresh water, since he knows the pressure drops through his own jackets, and is able to specify a heat exchanger with a known pressure drop for a given capacity. However, he is unable to standardize on a salt-water pump, because the piping varies so widely that the head is never known until the individual case is considered. It is therefore recommended, in order to save time and individual engineering, that the salt-water pumps in all cases possible be driven by motor, or otherwise separated from the engines.

Lubricating-oil pumps of the plunger type are particularly unsatisfactory and should always be rotary. In most cases of auxiliary engines, they are either of the wet-sump type, or the ship design is such that the oil can drain by gravity into the sump tank. In such instances, only one lubricating-oil pump is required, and the engine builder is therefore permitted to standardize.

USE OF BUNKER C FUEL

Many questions arise concerning the burning of Bunker C, or other heavy types of fuel oils. There is little question but that future developments will pave the way for burning these heavy oils at higher speeds than so far has been found practical. It is quite evident, however, that speeds and ratings are yet somewhat limited by the use of heavy fuels. It has been demonstrated through years of field experience that, after certain design requirements are met, fuels up to 10 per cent Conradson carbon and up to 2000 S.S.U. viscosity at 100 F can be satisfactorily handled by auxiliary engines. However, if the Conradson exceeds 5 per cent, or the viscosity exceeds 400, it is felt that it is very wise to limit the rated bmep to about 75 and the rpm to about 450. In any case, fuels should be heated sufficiently so that the viscosity at the engine should not exceed 200 S.S.U. and preferably as low as 100 S.S.U. If these precautions are heeded, there should be no difficulty whatever in the handling of heavy fuels, even up to 10 per cent Conradson carbon and up to 2000 S.S.U. at 100 F.

Most engine builders have learned that engine performance is aided by an increase in water temperatures. The reason the older engines seemed to perform better with lower temperatures was that formerly we did not fully appreciate the necessity of a low-temperature differential, and therefore a high flow rate. The low-temperature differential prevents hot spots by circulating sufficient water to even up the temperature throughout the engine. It is recommended that the temperature differential across the engine should not exceed 20 deg. Under such conditions, it can be shown that, from the angle of the operation of the engine iself, some improvement can be expected if water temperatures are increased to 160 or even 180 deg. The only difficulty with raising the temperature to such an extent is the comfort of the operating personnel, since it greatly increases radiation into the engine room and makes all engine parts too hot to be handled. Furthermore, with such engine temperatures, the intake air should be piped out of the engine room in order not to penalize the engine with such high-temperature air. When increasing operating temperatures, heavier lubricating oil should be used so that the same operating viscosity may be maintained.

OPERATING HIGH-SPEED AND LOW-SPEED ENGINES IN PARALLEL

Under prevailing conditions, a common practice is to install on short notice perhaps several makes and types of auxiliary engines in one engine room, in order to get the capacity needed in the time required, or to increase the capacity in a given engine room. Some difficulties have been experienced when installing high-speed engines to operate in parallel with lower-speed units. There is no basic reason, at least when considering direct current, why this cannot be done, except a consideration of flywheel effect. The high-speed engine automatically needs comparatively small wheel effect and, therefore, is usually designed that way. Several of these high-speed engines would parallel satisfactorily, but when installed in parallel with slow-speed units having heavy wheels, difficulty is frequently experienced because of the fact that the high-speed unit, having less wheel effect, reacts more quickly to load changes and therefore causes a considerable amount of surging. This is particularly true where the high-speed unit has a large number of cylinders, compared with the slow-speed unit. This should be taken into account when two different types of units are combined.

Check List for Manpower Utilization

(*Continued from page 411*)

frequently the blame is put on things outside of the company's control. Yet where counseling programs and exit interviews are used, many employees who would have separated from the organization have been retained by readjustments in either internally or externally unfavorable factors.

The tenth and final item to check for full manpower utilization is whether there is a program of maintaining satisfactory relations among workers and between workers and the management. The will to work conscientiously depends on that simple word "morale," and morale is made up of a lot of little things. Perhaps no greater morale builder is possible in any organization than the development of the team spirit—and the team I refer to is the combination of workers and management. To accomplish that best requires an easy two-way flow of information between management and the workers. All of us like to feel that we are a vital part in the organization—that we're on the team. We want to be recognized for what we can contribute to the company's progress with our hands, our hearts, and our heads. Worker satisfaction does not stem alone from written generalities as to company policy, nor from rallies, or posters. These are important; most important is the visible evidence of genuine collaboration in hour to hour dealings.

In conclusion, then, it seems to me that the most effective manpower utilization can be obtained through sound management practices. Good management requires that the organization structure, the planning, the control, the layout, the methods, and procedure aim toward personnel economy. It requires that there be an active co-operation with the military necessity by tapping the labor supply in least need by the armed forces. It means careful placement, full use of scarce skills, and use only of scare skills where they are absolutely essential. Good management means a continuous training in manual and management skill for increased production. Good management means a greater implementation of the role of psychology in dealing with the human-relations problems so that individual and group effort can be stimulated toward the highest standard of quality and quantity of production. Generally, then, manpower utilization will be achieved in direct ratio to the effective use of modern tools of management.

MAINTENANCE *of* ELEVATOR HOISTWAY *and* CAR ENCLOSURES *and* EQUIPMENT[1]

Elevator Service Bulletin No. 3[2]

II HOISTWAY ENCLOSURES AND PROTECTION[3]

1 CAUSES OF HOISTWAY-DOOR ACCIDENTS

A FALLING car is popularly considered to be the greatest of elevator hazards. Although spectacular, such accidents actually result in only a small percentage of the serious or fatal injuries. At least 75 per cent of all elevator accidents occur at the hoistway door. These are due to: (*a*) tripping or slipping at the car entrance, (*b*) being caught by car, (*c*) falling down the hoistway, and (*d*) being struck or caught by door.

(*a*) *Tripping Hazard.*

2 Tripping or slipping is generally due to:
Difference of level of car and sill.
Poor condition of floor surface at landing or car entrance.
Insufficient illumination of threshold.
Excessive clearance between car and sill.

(*1*) *Differences of Level.*

3 Differences of level may be due to unskillful operation or, particularly in the case of self-leveling elevators, to poor adjustment. Many tripping accidents occur even when the difference of level is less than 2 inches.

(2) *Correction of Bad Leveling.*

4 Bulletin No. 1[2] points out "inching" at landings shortens rope life. Out-of-level landings set up a tripping hazard. Operators should be trained to make accurate stops. On elevators not equipped with automatic leveling, controllers and brakes must be kept in proper adjustment to enable the operator to make accurate stops. Self-leveling equipment must be kept in adjustment as the operator in such installations has no control of the final stop. These adjustments must be made by a competent mechanic, preferably an employee of the company which made the original installation.

(3) *Slipping Due to Floor Conditions.*

5 Many elevator safety codes require the landing sill to be of nonslip material. Sills, worn smooth, should be replaced or the surface may be roughened. Broken sills should be repaired or replaced.

(*4*) *Tripping Due to Floor Conditions.*

6 Holes in car flooring or badly worn coverings are a serious tripping hazard. When repairing or replacing flooring or floor covering, the finished floor should present a continuous flush surface.

7 Excessive clearance between car and sill should be eliminated.

8 Difference in level between landing and car sill and adjacent flooring should be eliminated.

(*5*) *Threshold Illumination.*

9 A minimum illumination of two foot candles is desirable on the threshold at elevator entrances. A 100-watt, metallic-filament lamp placed 8 feet 3 inches above the landing edge of the car platform should give approximately this illumination. When elevators are located close to building entrances, values of illumination should be considerably higher, as a person's eyes, adjusted to outdoor sunlight, do not rapidly readjust for low intensities. Luminaires and lamps should be cleaned periodically, and blackened or old lamps replaced with lamps of proper wattage and voltage ratings.

(*b*) *Hoistway-Door Accidents.*

(*1*) *Difference Between Interlock and Contact.*

10 There is misunderstanding as to the difference between a hoistway-door interlock and a hoistway-door contact. An interlock prevents the motion of the car (except for leveling) when the door is opened *or unlocked*, as the interlock contact cannot be established before the door is closed and locked. A contact prevents the operation of the car when the door is open, and a door latch prevents the opening of the door from the landing side when locked, but this combination cannot insure the locking of the door before the car leaves the landing.

(2) *Protection Afforded by Interlocks and Contacts.*

11 Properly constructed and maintained hoistway-door interlocks will greatly reduce the number of hoistway-door accidents. The use of hoistway-door contacts alone will reduce the number of door accidents but still allows the door to be opened with the car away from the floor, permitting a person to fall down the hoistway. The use of door interlocks rather than door contacts and independent locks is recommended.

2 INTERLOCK INSPECTION

(*a*) *Setting of Switches.*

12 The position of the door at which the contact is made should be checked at least once a year. This is done by closing the door slowly and, as the car starts, measuring from the landing side the clear opening between the edge of the door and the nearest face of the jamb. This test should be made while operating the car at the lowest possible speed. Sequence relays, where used, should be by-passed during this test. If the contact is made before the door reaches full closure,

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[1] Prepared by the Executive Committee for the Safety Code for Elevators, Dumbwaiters, and Escalators of the American Standards Association.

[2] Bulletin No. 1, Elevator Wire-Rope Maintenance, appeared in MECHANICAL ENGINEERING, February, 1943, pp. 110–112. Bulletin No. 2, Maintenance of Elevator Mechanical Safety Appliances, appeared in MECHANICAL ENGINEERING, May, 1943, pp. 350–352, 359.

[3] Part I, Introduction, omitted from this installment, is substantially the same as appeared in connection with Bulletin No. 1.

the interlock must prevent the door being reopened more than 4 inches. The contact must be made only within this range.

(b) Inspection of Switch Parts.

13 The interlock contacts should be inspected at least twice a year. Contacts that are pitted or burned should be cleaned or replaced. Wires should be checked to see that they are not loose and that the bare portions of wires are well separated from each other and from grounded metal parts. Interlocks should be protected against grounds or short circuits due to water used for washing landings or platforms. Such water usually contains salts or acids which may readily break down insulating material.

(c) Alignment of Locking Parts.

14 The fastenings which hold the switch box to the hoistway enclosure or door buck should be checked for tightness. Where locking members enter the switch box, check its alignment with the opening in the box and, if necessary, correct any misalignment.

(d) Alignment of Switch Parts.

15 Current-carrying parts should be in alignment *when the hoistway door is fully closed.* Do not try to check alignment of parts when door is partly open as many types of switches are purposely made with sliding or wiping contacts which reach final alignment only when the door is fully closed.

(e) Inspection of Door-Locking Mechanism.

16 Door-locking mechanism should be checked to see that the door is properly locked when the car is not at the landing. With some locking mechanisms the wear of pins may permit the locking member to be displaced, allowing the opening of the door from the landing side. Where the bottom of the door can be displaced more than $\frac{1}{4}$ inch due to wear, the guide pins or bars should be replaced or the slot in the landing sill relined.

(f) Inspection of Door Closers.

17 Door-closer arms should be examined for lost motion. Where excessive lost motion is encountered, correction should be made by a qualified mechanic. Hydraulic door checks should be examined to see that they contain the proper amount of fluid and that proper cushioning action is provided. If necessary to add fluid, be sure it is of the same quality and viscosity as that recommended by the manufacturer. Check all fastenings to doors, door bucks, and sills for loose or missing screws or bolts, tightening or replacing if necessary. Check broken-arm closers to see that the toggle bar is in the locked position.

3 HOISTWAY-DOOR CONTACT INSPECTION

18 Hoistway-door contacts should receive the same inspection and maintenance as is recommended for the interlock-switch mechanism.

4 HOISTWAY-DOOR LATCHES

19 Hoistway-door latches wear and, when worn, may permit the door to be opened from the landing side. When the door is shut rapidly a worn latch may permit the door to rebound to a point beyond the locking range and the door be left unlatched, permitting destructive arcing of contact surfaces.

5 MAINTENANCE OF DOOR HARDWARE, INTERLOCKS, AND CLOSERS

20 Frequent cleaning and use of proper lubricant on door hangers and tracks will aid in reducing the fatigue of personnel and prolonging the life of equipment. Interlock mechanism and door-closer parts should be properly lubricated, but excess oil should be wiped off.

III HOISTWAY DOORS AND GATES

1 HORIZONTALLY SLIDING DOORS

21 Examine horizontally sliding doors for alignment, broken or defective panels, defective latches (See paragraph 19), interlocks, or contacts (See paragraphs 12–16 and 18). Bent door sections should be straightened or replaced. Loose or damaged panels should be repaired or replaced. Examine door hangers for wear or lost motion. Be sure the door cannot be displaced from its guides. Correct defective conditions. See that glass vision panel is intact and held securely (See paragraph 25).

(a) Cleaning of Door Grooves.

22 Both hoistway and car-door track grooves should be kept clean and free from foreign material. Dirt-escape slots aid in keeping grooves clean and are recommended where practical. They should be at least $2\frac{1}{2}$ inches long, being located in front of the guide pins when the door is in the fully opened and closed positions.

(2) Vertically Rising Gates.

23 Vertically rising gates should be examined for alignment, worn suspension ropes, worn or badly aligned sheaves, worn guides, and to determine that gate counterweights operate freely and are enclosed.

(3) Vertically Sliding Biparting Doors.

24 Examine vertically sliding biparting doors for alignment, worn suspension chains, worn or badly aligned sheaves, worn guides and guide shoes, loose guides, broken or defective latches and interlocks (See paragraphs 12–16). Check doors for free operation. Bent door sections should be straightened or replaced. Loose or damaged panels should be repaired or replaced. Adjust door stops, if necessary, so that the open door will be level with the sill. See that vision panel glass is intact and securely fastened (See paragraph 25).

(4) Replacement of Vision Panels.

25 If the glass in a vision panel is broken, the elevator must not be run until the glass is replaced or the opening covered temporarily. When replacing glass it is recommended that, where necessary, the clear opening be reduced by the insertion of intermediate bars or muntins so that it will reject a 6-inch-diameter sphere.

IV HOISTWAY ENCLOSURES

1 INSPECTION

26 Examine hoistway enclosures to be sure that they are firmly fastened to building members. Broken, defective, or loose panels should be replaced or repaired. Where codes require covering over grillwork, see that such material is installed and is securely fastened either to the grillwork or to supporting structural members. Hoistway and machine-room enclosures should be inspected for loose plaster or mortar and where found should be removed and the wall replastered or repainted.

2 CLEANING AND PAINTING

27 Periodic cleaning of machine rooms, top and bottom of cars, hoistway walls and pits will improve operating conditions and reduce fire hazard and wear of equipment. It will also decrease the possibility of serious fires, with the resulting loss of service of equipment and extensive replacement of critical materials. Elevator pits should be kept clean and dry; they should never be used for the storage of materials. The painting or treatment of concrete floors and unplastered walls in machine rooms with sodium silicate (water glass) or similar compounds will decrease the amount of dust and grit which might otherwise find its way onto relay and contactor surfaces

(Continued on page 459)

GLASS *for* PRECISION GAGING

By COL. H. B. HAMBLETON

CHIEF OF GAGE SECTION, U. S. ORDNANCE DEPT., WASHINGTON, D. C.

THE subject of glass gages has aroused more interest and publicity than anything previously brought to my attention in this otherwise rather neglected industry. When I say gaging has been neglected, I mean from a publicity standpoint and not technically. It is common knowledge that in the last few years, great progress has been made in gaging technique, and the development of precision-measuring instruments has gone forward by leaps and bounds.

The glass-gage project started early in July, 1942, when we discovered that the A. H. Heisey company of Newark, Ohio, had experimentally produced a few glass gages made from some old glass candlesticks for a concern in the Middle West. This company produced these gages for our use and, after considerable experimental work, we decided that this project was worth following and appeared to have enough value to warrant the concentrated energy of several glass manufacturers.

About this time, the Corning Glass Works of Corning, N. Y., and the T. C. Wheaton Company of Millville, N. J., became interested in glass gages, and the Ordnance Department requested them to give it the benefit of their long experience in glass technique. These two outstanding glass producers have given us their wholehearted co-operation.

Glass is something new to the gage industry and gage users and gages are something new to the glass industry; with this in mind we must expect problems during the early stages of the conversion effort. It is not so many years ago that steel was a problem to the gage industry. Many gage users of the last war and the following decade will recall the problems of cracked gages and dimensional instability resulting from insufficient metallurgical research on steels and their heat-treatment for gages. The problems of steel for gages were overcome by research and development carried on between the gage industry and the steel industry.

During the twenties considerable research was carried on to determine the steels that were best suited to provide adequate gage-wear life. In this war we must have similar co-ordination in research and development between the glass industry and the gage industry to insure the success of the glass-gage-conservation effort. We have a few "doubting Thomases" that scoff at the glass-gage effort because of the relatively small steel savings that will result. To them we can only say that the sum of a number of small contributions will result in a sufficient major contribution to steel conservation that will enable us to renew production of armament that is now hindered by steel shortages. Armies are made up of individuals each one of whom contribute their bit. Small contributions must be made in conservation as well as everything else to insure our victory in this War.

Substitution for conservation by the Ordnance Department has in many cases opened new horizons in the engineering field itself; many of our substitutes have been found to be superior to the material originally specified. We are confident that our glass-gage effort will result in new horizons for the gage industry and gage users. In the glass industry there is a process now in use that forms glass to extremely close tolerances on internal functions such as holes and tapers; this process requires a very accurate mandrel on which the glass is shrunk or molded. We in ordnance have many special gages that are not normally used in commercial manufacture; examples of these are chamber and ogive gages for ammunition; these consist of internal tapers or curved contours with very close tolerances. The glass industry is now working on the development of manufacture of chamber and ogive gages by this precision shrinking process. If no results other than this development were successful in the glass-gage effort, all the time and energy spent on this project would be justified. However, we are confident that more new horizons will be uncovered by the glass-gage effort other than the precision shrinking process, and new developments will probably include cheaper gages and the release of critical machine-tool capacity.

In every new development there is a tendency to put the new product to the toughest tests. In ordnance we have given glass gages a tough test on gaging cartridge-case mouth diameters and we are enthusiastic over the results.

The Frankford Arsenal cartridge-case shop has used a glass gage for the inspection of 57-mm cartridge cases This gage performed 260,000 gaging operations before it was worn-out, and for the first 160,000 operations the wear was only 0.00005 in. A steel gage for this same duty normally has a life of 60,000 to 70,000 operations. At the present time, the Ordnance Department has several glass gages under test and the results of these tests will be made public soon.

Outside of ordnance we have heard of some tough tests of glass gages on parts having extremely close tolerances where even chrome-plated steel gages do not "stand the gaff." With very little development yet accomplished on glass compositions and treatments, we must expect some of the first glass gages to fall by the wayside, but if the research and development that has been put into chrome-plated gages had been put into the development of glass compositions and treatment, the performance of glass in close-tolerance applications would probably have been more favorable. In all close-tolerance gaging functions, the rubbing of the gage during each application creates a serious wear problem. Fortunately in ordnance we are not bothered with many close-tolerance gaging functions, because for years we have had an effective gaging policy that quickly eliminates close tolerances where they are not necessary. Our experience has been that rigid adherence by effective gaging to drawing requirements usually results in liberalized tolerances. Because of our ordnance drawing tolerances we are not much disturbed about the failure of a few glass gages for applications with close tolerances.

DEVELOPMENT PROSPECTS

In every new mechanical venture, new "bugs" develop that must be overcome by research and development; pioneering in a new development requires fortification against the satisfied few. Many will recall the strenuous objections to four-wheel brakes and steel bodies in the automotive industry. We must not let the "satisfied few" stand as an obstacle to the success of the glass-gage effort or any other progressive engineering development.

While more or less in the experimental stage for the last six months, with much yet to be learned, we are convinced from our experience at Frankford Arsenal that glass gages have possibilities and are so efficient that we fully expect them to become a permanent fixture in the industrial world after this war. You may also be surprised to know that surface plates are being made of glass and are commercially obtainable.

Contributed by the Production Engineering Division and presented at the Spring Meeting, Davenport, Ia., April 26–28, 1943, of The American Society of Mechanical Engineers.

For another article on glass gages see Mechanical Engineering, April, 1943, pp. 274–276.

Glass gages in sizes under $^3/_8$ in. are difficult to produce and will probably never be commercially made. However, synthetic sapphires, synthetic rubies, and other synthetic jewels, with considerable resistance to breakage and with a hardness which will readily scratch the toughest glass, are being produced by the Linde Air Products Company and have been extensively used by the Hamilton Watch Company. The only discernible difference between synthetic sapphires and rubies and the genuine article is the grain structure which is detectable only under a microscope.

The approximate cost of these synthetic jewels, which are produced in rods, would be in the neighborhood of 20 cents per inch, and they are furnished in sections approximately 8 to 10 in. long. Single crystals are also produced approximately $^3/_4$ in. in diameter and 2 in. long, which, in the case of the sapphire and ruby, must be split in two because of internal stresses.

Frankford Arsenal has procured acceptable glass gages from the Corning Glass Works, Corning, N. Y.; Fisher and Porter Company, Hatboro, Pa.; the A. H. Heisey Company, Newark, Ohio; T. C. Wheaton Company, Millville, N. J.; Specialty Glass Company, Newfield, N. J.; and the Blue Ridge Glass Corporation, Kingsport, Tenn. An interesting development is the flat snap gage produced by the Blue Ridge Corporation. This gage is made from one of their standard plate glasses and will stand considerable abuse. While most glass companies are now producing gage blanks the Ordnance Gage Company, Philadelphia, Pa.; Turner Gage Grinding Co., Detroit, Mich.; Abdite Gage Co., Dearborn, Mich.; and Langlois Gage Co., Detroit, Mich., have marketed finished glass gages and report satisfactory results by users.

One of the questions always raised is the method of measuring hardness of glass comparable to the indenter methods used on metals. Indices showing the scratch hardness of certain glasses have been set up and the Bureau of Standards has developed a method known as the Knoop indenter which has been used for measuring the hardness of glass. For a description of this method, see National Bureau of Standards Research Paper RP 1220. The question of hardness may not directly be a factor in the wear of glass gages, and it is our belief that the finish on the gage will be the greatest factor in its wear. We further believe that one of the glass producers will, by research, provide tougher glass and this combined with a better surface finish will materially increase the wear life of glass gages.

The question of standard drawings and specifications is also recurring. To answer this, may I say Frankford Arsenal, with the aid of the more progressive glass manufacturers in this country, has formulated tentative specifications and provisional standard drawings of glass gages. These standards will, in so far as possible, be dimensionally the same as those of the American Gage Design Standard, shown in publication CS8-41, published by the National Bureau of Standards.

It will be remembered by persons in the gage-making industry that this standardization of steel gages, which was formulated before the war, with their aid, has insured complete co-ordination and interchangeability of all gage parts manufactured during this emergency, and I know you will agree with me that this standardization has eliminated a great deal of confusion that would have existed had this work not been completed.

It might be appropos at this time to point out some of the advantages of glass gages: Many greasings and degreasings are eliminated. Perspiration of the inspector's hands has no corrosive effect; scratches on glass do not raise a burr or change the effective size of the gage; the thermal conductivity of glass is low and heat transferred from the hand of the inspector will not affect the gaging dimensions; glass is approximately one third the weight of steel and several types of gages which are now made solid will be hollow when made of glass, which will obviously make the glass gage much lighter and more advantageous to use.

GRINDING TECHNIQUE

Both the Corning Glass Works and the T. C. Wheaton Company have been experimenting with the grinding and finishing of glass gages. These two glass producers have arrived at practically the same conclusions. I will quote data on the three most important considerations in grinding of glass, viz., grit, bond, and surface speed, as recently furnished me by Mr. Thompson of the Corning Glass Works.

Grit. The work to date permits definite conclusions concerning the grit for rough finishing—this can be 50 or 60. But for the final finishing much work remains to be done. We know, however, that a very smooth surface is obtainable with 150-grit wheels, but only when the coolant is shut off during the final passes, when the depth of material being removed is of the order of 0.0001 in. per pass. The glossy finish thus obtained is the result of slight surface glazing of the glass due to the frictional heat developed. Although we have not as yet obtained delivery of the grinding equipment which will enable us thoroughly to study the over-all problem in all its aspects, our accumulated experience on gage finishing and other glass-finishing operations leads us to believe that further improvements can be made by resorting to wheels of considerably finer grit.

Bond. Until we are able to accumulate evidence to the contrary, we believe that "soft" vitreous bonds are most nearly foolproof for glass finishing despite the fact that they are definitely weaker mechanically. As regards the latter, we have been assured by abrasive-wheel manufacturers that even the softest bonds can be made strong enough to eliminate any possibility of personal hazard when the wheels are properly used.

Surface Speed. I have gathered the impression from numerous contacts with gage makers that they are somewhat worried about the problems involved in adjusting speed of their present machines, which were designed for work on steel, to other speeds which would presumably be better adapted to glass grinding. The further we get into the glass-gage business, the more we are inclined to believe that speed is a relatively secondary problem and that there may be no necessity for altering the driving mechanism of existing machines.

Initially, when we reported on our accumulated experience in glass grinding, we stated that our best results have been obtained with surface speeds of 2500 fpm or less. This is still essentially true, but it must be remembered that our machines have been especially fitted for glass grinding only.

RESEARCH CONTINUES

Much of the mystery of glass grinding is being dissipated by continued application of the principles of research. The wheel-speed problem seems to be simmering down to a relatively simple problem in thermodynamics. All glasses are, of course, much less conductive of heat than metals; in fact, this is one of the advantages of glass as a gage material. But, correspondingly, this also means that the heat generated in the grinding operation tends to be stored up in a shallow depth of the glass gage. This, in turn, paves the way for "rather severe thermal strain." And, if the latter becomes excessive, there is possibility of thermal breakage or checking of the blank while it is being ground. Obviously, the answer is to remove the heat of grinding as rapidly as it is generated; or, in other words, to balance heat input and heat removal. In general, the quantity of heat generated will be a function of the wheel speed and the depth of cut, and the rate of removal will be, to a large extent, determined by the quantity and distribution of coolant. It follows that when the flow and distribution of the coolant is reasonably well standardized, there remain only two variables, both of which are subject to control, namely, depth of cut and surface speed. Accordingly, if the surface speed is high, that is, approximately 6000 sfm, which is conventional for steel grinding, the heat input can be correspondingly reduced by reducing the depth of cut. Therefore there is no reason why there need

be any alteration in speed of existing machines in order to grind glass satisfactorily. It is simply a question of finding the best combination of bond and grit of wheels to produce the most highly polished finish. On this point we expect to have rather specific information available, within a reasonably short time after the equipment being made available to us is placed in operation. Oddly enough, our biggest bottleneck now is getting delivery of the desired assortment of grinding wheels for this purpose.

In regard to the coolant required for grinding glass, it has been found from experience that plain water is all that is required; however, it is necessary to provide some agent to prevent rusting of the machine. For this, International Chemical Company's No. 219 oil, has been used diluted 25 to 1.

In using the taper-lock handle, it will not be necessary to grind the taper on the glass shank as this can be molded close enough to give the required fit.

It is entirely possible to grind centers in the ends of plugs, using a tungsten-carbide drill and lapping with a center lapping stick, such as a Norton 60 Q $^1/_2 \times 2$; the blanks will be supplied by glassmakers with the centers ground in. The question has been asked many times, whether the molded male centers could be supplied on the blank. This is impractical to do in glass-molding procedure.

THE ORDNANCE GAGE PROGRAM

Early in August, 1940, it became evident that the peacetime capacity of the gage industry, which is normally about $3^1/_2$ to 4 million dollars, was apparently insufficient to meet the visualized load of the projected munitions program, taking into consideration Ordnance, Air Corps, and Navy requirements. The problem was presented during the summer of 1940, approximately one year and three months before Pearl Harbor, to the Office of the Assistant Secretary of War, who is charged with industrial planning. Mr. Mason Britton, who was the chief of the tool section of the Advisory Commission, Council of National Defense, which office later became the War Production Board, took this problem under advisement.

From surveys made in September, 1940, the first general gage expansion program was initiated and approved by President Roosevelt, Oct. 15, 1940, to the extent of four million dollars for increased gage-making facilities. This has been followed by four other expansion programs; the total resulting in the expansion of more than 100 gage-making plants at a cost of approximately twenty million dollars. It is estimated that these facility expansions with other normal expansions will have increased the gage-making capacity of the country from four million dollars in 1940 to approximately 125 millions at present.

From this short résumé of the gage-facilities-expansion program, it must be quite evident that the Ordnance Department has been closely following the trend of gage requirements and providing new sources of supply as fast as the demand presented itself.

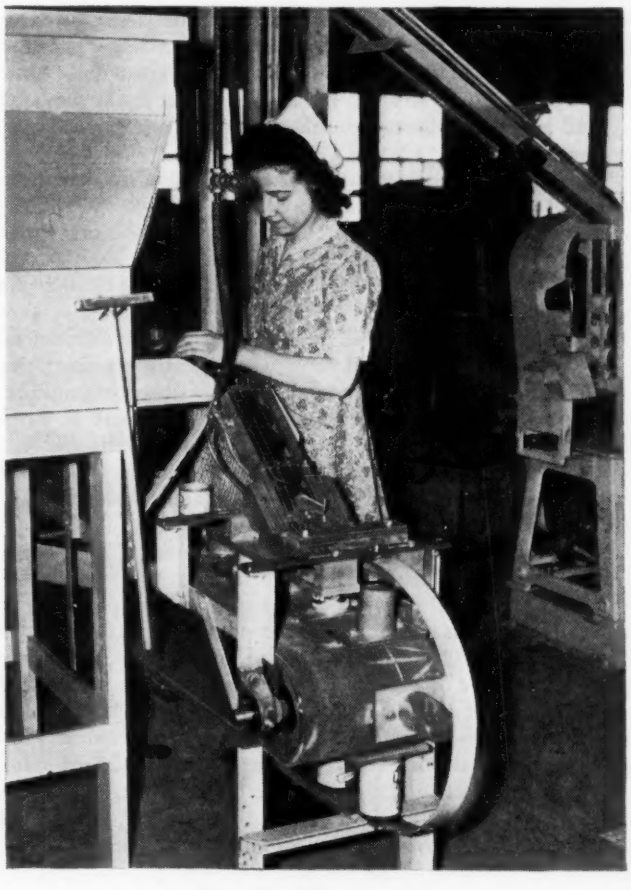
This balance of supply and demand has been accomplished by studying production programs in advance and increasing gage facilities far enough ahead of the programs to meet the objective. A definite policy of design, distribution, surveillance, and procurement was set up before this war and with the cooperation of industry, the Ordnance Department has been able to carry out its gage program objective.

The Ordnance Department has developed a gaging policy which many agree is superior to most other policies because it recognizes the vital importance of wear allowance and combines wear allowance with gage-makers toleranees, both allocated entirely within the work tolerance zone. This allocation is graphically and dimensionally described on an Ordnance chart which appeared in *Iron Age* for Sept. 3, 1942.

Nineteen Ordnance gage laboratories were established at manufacturing arsenals and in ordnance procurement districts before this emergency. Those in the districts were located in universities for the purpose of training personnel in this highly specialized work. The foresight of the Ordnance Department in equipping these laboratories in the years prior to the emergency can be visualized when one considers the serious bottleneck which developed shortly after the beginning of this war in the supply of precision-measuring equipment, owing to the restriction of foreign sources of supply and the longer period required to manufacture this type of equipment.

The district laboratories are responsible for constant gage surveillance to detect worn or damaged gages being used by Ordnance Inspectors.

The Ordnance Department is constantly striving to improve gaging methods, particularly with the view of obtaining faster inspection. During this emergency many new types of gages have been developed, including multiple-purpose gages employing electrical means for amplification, precisionnaire gages for measuring gun bores, special dial indicators for the same purpose, and optical projectors for measuring irregular parts. The development of high-speed multiple-purpose gages has been timely because of the difficulty encountered in employing sufficient inspection personnel. In conclusion, may I say that the Ordnance Department is greatly indebted to industry for its fine co-operation, without which it would have been impossible for us to meet the objective of this enormous program.



DOUBLE METAL SAVING

(American Can Company engineers, faced with sharply increased demand for all-fiber cans to replace metal and metal-end containers formerly used to pack such products as dry chemicals, powders, birdseed, dehydrated foods, and cocoa, could not get steel to make new machinery such as they had been using. So they devised the simplified but efficient machine shown, which has wooden cap chute, wooden capping jaws, and wooden hopper for the caps. The conveyer is an ordinary packaging conveyer to the belt of which were attached wooden posts on wooden bases. Practically the only metal used was in stanchions and bearings. The metal machine produced about 40,000 containers daily; the new one is already up to 35,000 daily, and better production is expected of it.)

Postwar Plans for an INTERNATIONAL MONETARY AUTHORITY[1]

By RALPH E. FREEMAN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

DURING the last few months the project for an international currency system has been a lively topic of public discussion. Two plans have been suggested, one British and the other American; and although these plans differ somewhat in detail they seem to be alike in providing for (1) a gold standard in terms of which the various currencies are to be valued and (2) a bank or clearing center to furnish machinery for the clearance of international payments. Much of the discussion of this subject has been rather superficial, being concerned with the advantages of an international currency backed by gold and with the convenience of a system of international bookkeeping that would obviate the necessity of transporting gold from one country to another. In fact, however, the real significance of an international monetary authority will be, not in the invention of some new form of money, nor in the creation of a clearing system, but rather in the measures it will adopt to influence the international flow of goods and capital funds.

In looking to the postwar years one may predict that international economic relationships will pass through three different stages. The first will be the stage of relief during which starving populations will be fed and devastated countries supplied with goods and services necessary to enable them to set their industries in motion. Presumably much of the flow of goods during this period will proceed independently of financial considerations. The second stage will be one of readjustment to the effects of the war; trade will be on a price basis and free-gift agreements will have been abandoned. This will be a trying period, for the conditions of world trade will have been upset as the result of war, and large disequilibriums in the balances of international payments are to be expected. The third stage will be reached only after the nations of the world have re-established their industries, and international trade has settled down into fairly stable channels.

The international financial authority to be set up must cope with the problems arising in the second as well as in the third of these periods. In the second period, for instance, it is likely that, irrespective of the relative values assigned to the various currencies, there will be considerable disequilibrium in international balances of payments. In the devastated countries imports will be greatly in excess of exports—their need for foreign goods will be great while their capacity to produce and sell in foreign markets will have been seriously impaired. And in the case of other countries exports will be correspondingly large and imports small. Hence the first and most pressing task for the international authority will be the filling in of gaps in international payments that will appear as the result of import-export discrepancies.

Under both British and American plans the international bank or clearings center is expected to furnish a pool of international assets for short-term use. This fund would be provided in part by initial contributions of gold or currency from the participating nations and in part by balances left in the clearing account by nations with export surpluses. Thus the system is designed to take care of some initial inequalities in international payments arising from unbalanced trade conditions. Countries with import surpluses would be permitted to overdraw their clearing accounts up to certain limits. But as the deficit countries reach the limits of their overdrafts, other methods of adjustment will have to be used. Either the surplus countries will have to make additional loans to the deficit countries or corrective measures applied to remove the fundamental causes of disequilibrium.

The correctives must have the effect of removing or decreasing the export and import surpluses. They may take the form either of alterations in the rates of exchange or of changes in the relative price levels of different countries. Raising the foreign-exchange value of a nation's currency tends to reduce imports and increase exports, while lowering the exchange value has the opposite effects. Raising and lowering the level of a country's domestic prices produce similar results: higher domestic prices attract imports, lower prices stimulate exports. But the attempt to correct the disequilibrium by operating on national price levels is likely to encounter serious difficulties. It will be confronted by rigidities of costs, wages, and prices—rigidities that will have been enhanced by the war as well as by the effects of the social-security schemes that will have been introduced in most of the participating countries. Adjusting exchange rates will therefore be the more practicable corrective. But even this device will have to overcome many difficulties and prejudices. It will require a degree of international co-operation that has not heretofore been achieved except in time of war: it will require the abandonment of the beggar-my-neighbor policies of trade restrictions that have up to now been adopted by most nations in their international commercial intercourse.

It is doubtful, however, whether these fundamental correctives can be fully applied during the second stage of postwar development. Until the devastated countries have been able to get their industrial systems in working order, it is not reasonable to expect a balanced and stable world trade. Therefore it appears that during this stage international loans will have to be relied upon as the main equilibrating force. Of course, lending during the second stage will create difficult problems to be solved in later years, for trade will then have to be adjusted in such a way as to permit debtor nations to export goods to pay the interest on their debts and creditor nations to import goods to receive the interest.

A good deal of thought is now being devoted to such problems and interesting articles continue to appear in many of our leading journals. In a recent book[2] there is a section on international economic relations in which four different writers present their views. In one of the chapters of this section Mr. C. P. Kindleberger discusses some of the plans for international monetary control which have emanated from private sources

[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

[2] "Postwar Economic Problems," by Seymour E. Harris (editor), McGraw-Hill Book Co., Inc., New York, N. Y., 1943, 417 pp.

and this analysis throws considerable light on the official British and American plans herein referred to. He concludes the chapter in the following words: "Monetary stabilization, therefore, rests fundamentally upon the resumption of long-term capital lending on a significant scale. Proposals which ignore the basic problems of stability and aim merely to provide temporizing means to fill the gap in balance of payments on current account are doomed to fail."

Prof. H. E. Ellis, who contributes another chapter in this section, emphasizes the relatively subordinate role which exchange machinery will play in solving the basic problems of world trade. He points out that if because of tariffs, quotas, bilateral restrictions, and other obstacles to the flow of trade, fundamental disequilibrium remains, no ingenuity of clearing schemes will prevent the international machine from stalling. In discussing international monetary control, Professor Ellis expresses the opinion that the powers of the monetary authority should include not only the power to determine exchange rates but also the power to control the volume of purchasing power and hence the level of prices in important collaborating countries. "The adoption of this crucial over-all control has not only the great merit of really insuring international equilibrium but also of relieving the countries of the intrusion of international control into matters of the 'social budget' and wages. Such an international control is not without historical precedents, for example, the limitation of credit expansion by the Reichsbank under the Dawes Plan and the League of Nations' oversight of national treasuries and banks in the debtor countries of southeastern Europe."

This book contains sections dealing with other postwar problems in which the reader may be interested. The issue of full employment is discussed, problems of government finance, labor, and agriculture; and many of them have a bearing on international economic relations. One lays aside a book like this, however, with a certain hopelessness, realizing that there is a tremendously wide gap between what the experts think should be done and what the country is likely to do. Consider, for example, the suggestions of Professor Ellis for international monetary control. The Congress of the United States recently extended the life of our stabilization fund for another two years, clearly stipulating that the President's authority over the fund is not to include the right to use all or a part of it as a contribution to any postwar international bank or clearing system. Commenting on this limitation upon the use of our stabilization fund, Chairman Somers of the House Coinage, Weights, and Measures Committee said: "This indicates to me that there is not going to be any international bank."

Elevator Hoistway and Car Enclosures

(*Continued from page 434*)

and into machine bearings. Such painting or treatment should decrease minor service interruptions. The painting or treatment of unplastered hoistway walls will seal in loose particles of sand and mortar, thus preventing this material from reaching guide rails, shoes, undercar safeties, and buffers.

V CAR AND CAR EQUIPMENT

1 CAR INSPECTION

(*a*) ***Enclosures.***

28 See that the car enclosure is securely fastened to the platform and that bolts, screws, and other fastenings are tight. If, after tightening the fastenings, the car enclosure can be deflected far enough by a person leaning against it or by freight in contact with it as to cause the cab to strike an obstruction in the hoistway, additional stiffening must be provided.

(*b*) *Emergency Exits.*

29 Side exits should be tested by opening them. Where panels are held in place with locks, the key should be in the car. For automatic-operation elevators, the key should be in charge of the person who will answer the alarm bell.

30 Top emergency exits should be closed when a car is in service. Serious injury to passengers has resulted from objects which have fallen down the hoistway and entered the car through open emergency exits. Check to see that they may be opened from within the car. Where hinges are not provided, see that the exit cover is secured by a rope or chain to prevent it from falling down the hoistway.

(*c*) *Emergency-Exit Fastenings.*

31 Where thumbscrew fastenings are used, all thumbscrews should be in place and should be operable without the use of pliers or a wrench. If thumbscrews cannot be turned by hand, they should be freed and thoroughly lubricated, and when the panel is replaced the thumbscrews should be tightened by hand only. Both top and side emergency exits should be operable from the outside of the car.

(*d*) *Car Doors.*

32 Car doors should be subjected to the same inspection as hoistway doors and the same corrective measures taken (See paragraphs 20–22).

(*e*) *Car Gates.*

33 Car gates should be examined for excessive wear. If wear is excessive, the gate should be repaired or replaced. Where gates of the pantograph type are power-opened, the protective curtains should be examined to see that they are operating properly. Damaged or defective curtains should be repaired or replaced. Excessively worn bottom guides and badly worn rollers or track should be replaced.

(*f*) *Car-Gate Contacts.*

34 Car-gate contacts should receive the same inspection as is given to hoistway-door contacts (See paragraph 18). Be sure that the contact is opened mechanically as the gate is opened.

(*f*) *Car-Operating Panel.*

35 Examine car-operating panel and operate all devices thereon, including emergency stop, by-pass switches, motor generator switch, and pilot light, leveling and car light switches to see that they are functioning properly. Check car switch for return to, and latching in, the neutral position. See that emergency-release glass covers are in place, and that alarm bell and telephone are functioning. Adjust or replace any device not operating properly. All switch contacts in the car panel should be examined annually and defective contacts replaced.

(*g*) *Car Lighting Fixture.*

36 Examine lighting fixture for missing glass-holding screws. Replace missing screws and any broken or cracked glassware. Glass breakage and accidents may be prevented by backing off glass-holding screws about one-half turn after they have contacted the glassware. Clean the glassware and replace burned-out lamp bulbs.

VI SIGNAL SYSTEMS

37 Signal systems should be checked for loose or worn contacts, loose connections, and misalignment of parts. See that junction and outlet boxes and their cover plates are securely fastened. Replace burned-out bulbs. The use of a low-voltage supply will increase lamp life. Where transformers that have a number of taps have been provided to supply the signal circuit, use the lowest voltage that will give clear illumination to the indicator.

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Spreader-Stoker Firing

COMMENT[1] BY J. F. BARKLEY[2]

At the close of a paper on spreader stokers presented before the Society about five years ago, the writer stated that the limitations of such stokers in the field of larger boilers were not so very apparent and that it would be interesting to see the results of studies of its application in this field. The paper[3] on recent developments by R. L. Beers gives the results of further advances. Higher efficiencies are being obtained, and higher loads are carried.

A number of plant installations using the forward-moving grate have been visited by the writer and have been found to be providing very satisfactory ash removal. The firemen at the various plants were particularly pleased to be able to check ash conditions merely by reaching in at the boiler front and, with their bare hands, taking pieces of ash off the grate for examination.

As illustrated by the author, waterwall cooling is successfully used with the spreader stoker. The amount to be used, however, must be given careful study by the designer. On one of our government installations, where it was desirable to use a low-volatile coal from an economic standpoint, too much waterwall cooling was installed. Excessive smoke and high-carbon "fly ash" resulted from too low a furnace temperature. Until furnace changes could be made it was necessary to use a high-volatile coal to improve these results.

COMMENT BY H. C. CARROLL[4]

The author is to be commended on the brief history of the development of this type of firing and the accomplishment of more recent developments which have placed it in a position as one of the leading devices for burning solid fuel.

Perhaps the last and most important development is the advent of continuous ash disposal, where the size of the unit justifies its cost, which has put it in direct competition with accepted and long-established methods of fuel burning. The application of the moving grate to the overthrow stoker has removed most of the objections to the dumping type. Sustained burning rates of considerable increase, and higher sustained efficiency over the dumping type have been made possible.

It has been established that the hottest zone in this system of firing is well above the grate, partly due to some of the fuel's being burned in suspension; and as the grates are protected by an ash blanket to prevent heat penetration, with fuel-distributing parts practically outside the furnace, there is every reason to believe that the maintenance cost of stoker parts will be well below other types of competing stokers. Low power requirements of this type of firing increase net over-all efficiency. Refined automatic control is most vital and its proper application has much to do with obtaining high efficiency and smokeless operation with this type of fuel burning.

However, there is room for improvement in control of overfire air, especially in units which have to meet a wide range of load demand. The use of high-pressure air jets for the reinjection of fly ash and overfire air has many advantages over reinjection by steam jets. However, the amount of this overfire air is not as yet under automatic control. It must have sufficient velocity to overcome the high drafts of rear passes and dust-collecting devices. Under low load conditions, it often furnishes excessive air to the furnace. In larger installations the amount of fly ash collected is appreciable and has to be disposed of as collected, demanding a steady flow of injection air to avoid choking at the collecting points.

Considerable care should be exercised in selecting the amount of waterwall cooling, furnace volume, and grate surface to meet the particular load characteristics to which the unit is to be subjected, and the kind of fuel most likely to be used in order to realize high efficiency, smokeless operation, and reliable ignition at all times.

It is gratifying to note that the author recognizes the fly-ash emission from the furnaces of overthrow stokers, and if full recognition of this problem is given in the original layouts and designs of a unit, proper provisions can be made to insure definitely that no nuisance will exist under any load conditions. In the past, much of the objections to the spreader stoker have arisen from fly ash, often because of failure to recognize this inherent characteristic of burning in suspension. Also, the collection and reinjection of the fly ash pays dividends.

The fly ash from overfeed stokers, as stated by the author, is comparatively coarse and easily separated. This is frequently in the form of coke, light in weight, often in a swollen condition. Analyses frequently show as high as 75 per cent combustible matter in fly ash.

Some of the advantages which we have found in the application of overfeed stokers are:

That size consist of the fuel does not affect operation as in underfeed- and chain-grate-fired operation, and that proper distribution on the grate can be accomplished over a wide range of sizes and types of fuel.

That low-fusion, high-sulphur, high-volatile coals can be burned successfully even with preheated combustion air.

Due to the coal's being distributed on the grate in increments proportional to increments of steam demand, fluctuating load demands can be closely accommodated over the whole range of operation of the unit.

As the amount of burning fuel in the furnace at any one time is reduced almost to exact proportional instantaneous load demands, there is practically no loss of fuel in bringing the unit to a banked condition, as compared to large live-fuel beds maintained in other types of firing.

The rapid development of this type of firing, in which the author has taken no small part, is a distinct contribution to the art of steam generation.

COMMENT BY H. G. MEISSNER[5]

The author is to be congratulated on the sound engineering and progressive development work shown in this paper and in the plants described, several of which the writer has had the privilege to inspect. His work has helped materially to put the spreader stoker into the big-stoker class, especially in regard to the continuous-cleaning type.

His paper mentions several plants

[1] Published by permission of the Director, Bureau of Mines, U. S. Department of the Interior.

[2] Chief, Division of Solid Fuels Utilization for War, Bureau of Mines. Mem. A.S.M.E.

[3] "Recent Developments in Spreader-Stoker Firing," by R. L. Beers, MECHANICAL ENGINEERING, vol. 64, 1942, pp. 867–871.

[4] Head, Mechanical Engineering Department, Commercial Testing & Engineering Company, Chicago, Ill. Mem. A.S.M.E.

[5] Stoker Engineering Division, Combustion Engineering Company, Inc., New York, N. Y.

where spreader stokers have superseded other types of firing. In this connection we would like to point out that spreader stokers are also being used successfully to improve the performance or increase the capacity of existing chain- and traveling-grate stokers. In one recent installation, boiler capacity has been increased from 120,000 lb to 165,000 lb per hr, and maintenance materially reduced, by modifications in furnace design and by the installation of waterwalls and spreader stokers over the existing traveling grates.

This is not always feasible, but in many cases such revamping can be done at much less cost and use of critical materials than would be required for additional units, thus fitting into the war-production program. Careful engineerneering is essential in such work.

The coal grates, rapid ignition, load flexibility, and ability to burn either coking or free-burning coals, as noted in the paper, are definite advantages in connection with the improvements mentioned.

Conversion of oil-fired furnaces, as now required in many localities because of fuel-oil shortages, is also facilitated by use of spreader stokers, their flat grates and relatively shallow ash pits fitting in well with usual oil-burning furnaces.

This flat grate is easily covered with refractory, should the oil burners be put back in service; or a combination of coal and oil can be used, under favorable conditions.

It is evident, as the author states, that the spreader stoker is in an active stage of development and is already taking a major place in the present war program.

COMMENT BY L. A. SHIPMAN[6]

The spreader stoker in combination with the chain grate not only improves the ordinary spreader operation by discharging the ash continuously but it changes the fundamental principles of ignition as experienced on chain grates. No longer is the rate of burning limited by the rate of ignition of the chain grate. This changed operation allows higher burning rates which can be used by the designer in smaller grate areas for the same over-all fuel consumption without much increase in gas velocities.

There is also the possibility, because of this changed ignition–burning-rate ratio, using strongly coking coals on this combination where they have been impractical on the straight chain- or traveling-grate stoker. It would be interesting to hear from the author if such strongly coking coals have been used and with what results.

[6] Fuel Engineer, Southern Coal & Coke Company, Inc., Knoxville, Tenn. Mem. A.S.M.E.

Drilling Magnesium Alloys

TO THE EDITOR:

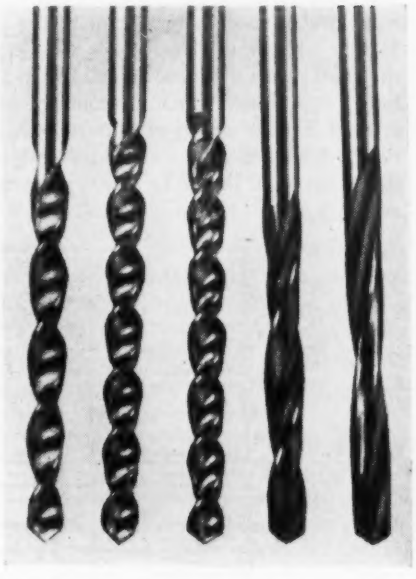
The excellent article on drilling deep magnesium alloys[7] by Messrs. Gilbert and Lennie indicates that similar results were derived as those developed by the writer in 1930 to 1932, which were published[8] at that time.

It is of interest today that alloys having the same analysis as "Elektron Leichtmetall," an old invention of I.G. Farben (Lautal) should be used throughout the world. This analysis is given in the following table:

Electron	Al	Zn	Mg
Cast—AZG	5.8–6.3	2.8–3.3	90.5–91.5
Pressed—AZM	6.2–6.5	0.8–1.2	93.0–92.5

In connection with the problem of drilling such alloys, the writer would like to present briefly some of the results obtained during the tests of 1930–1932, by which the shape of the drill point, the helix angle, speed, feed, torque, and thrust were measured.

Because of subsequent events, which eventually led to the war, a personal word of explanation concerning the conduct of the tests is necessary. The writer was at that time a Professor at Charlottenburg University, a post which later he was forced to relinquish. For the tests in question, machine tools, special twist drills, and Elektron material were provided by the writer. The measuring instruments used were designed in close collaboration with the writer's principal assistant, M. Kurrein, and were made by the laboratory mechanics. A second assistant, E. E. Lingemann, prepared his doctor's thesis on the subject, which was published in 1933 without the writer's consent. This thesis contained a compilation of the assistant's routine work. By that time the writer had left the University. The authors of the present paper referred to this work by Lingemann as item (6) of their Bibliography.



Drill:	I	H	C	A	B
Helix:	37	45	45	24/26	11/12

FIG. 1 TYPES OF EXPERIMENTAL DRILLS

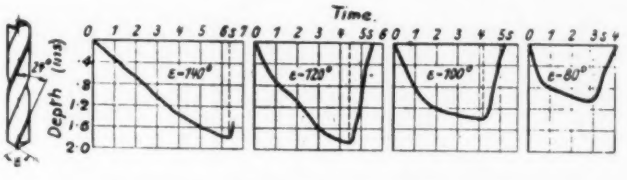


FIG. 2 RESULTS OF FIRST DRILLING TESTS

CONDUCT OF TESTS

For boring deep holes in Elektron-magnesium alloys, a series of special twist drills was made, which differed (1) by the inclination of the helical flutes, and (2) by the shape of the point.

A condition for all tests was that a hole having a depth at least 5 times the diameter should be reached, cutting dry. At first some nasty fires occurred from machining this inflammable material at high speeds, which were further spread by the use of watery fluids. During the first tests in 1930, we experienced great difficulty with drills of 11/12 deg and then 24 /26-deg helix angle, Fig. 1. At the end of a day's work, there were more broken drills than finished holes, without having reached the prescribed depth of 2 in. (50 mm), using a $^3/_{16}$-in-diam (5 mm) drill.

Then systematically, the writer changed the point from 140 deg (very flat) to 80 deg (very acute). The first results are shown in Fig. 2. The deepest hole, relatively, was made with a 120-deg point, using the ordinary 24-deg helix.

The recording instruments permitted us to measure the torque and, at the same time, the vertical thrust, either by changing the weight for creating the feed force, acting directly on the drilling spindle, or later by a positive feed which was increased up to 0.020 in. per revolution.

[7] "Drilling Deep Holes in Magnesium Alloys," by W. W. Gilbert and A. M. Lennie, MECHANICAL ENGINEERING, vol. 64, 1942, pp. 877–887.

[8] "Bearbeitbarkeit und Werkstättenausnutzung," by G. Schlesinger, *Zeitschrift des Vereines deutscher Ingenieure*, vol. 76, 1932, pp. 1281–1293.

The speed of the $^3/_{16}$-in-diam drill was increased to 20,000 rpm, corresponding to 1000 fpm peripheral speed. Then the helix angles were changed from 12 deg to 45 deg. The result, Fig. 3, was to reduce the axial thrust from 240 lb (110 kg) to 55 lb (25 kg), which remained constant for at least 2 in. of depth or more, whereas the 36-deg flute gave a small increase of thrust up to 80 lb (37 kg) from approximately 1.65 in. (42 mm) depth.

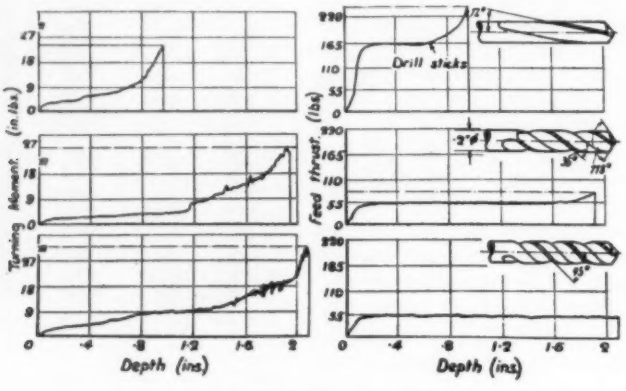


FIG. 3 EFFECT OF CHANGING HELIX ANGLE

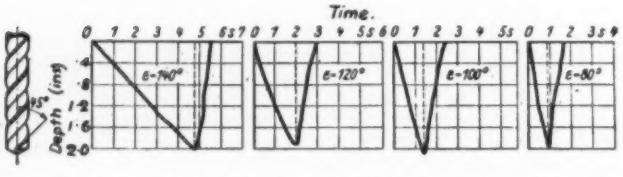


FIG. 4 RESULTS OF DRILLING TESTS ON ELEKTRON MAGNESIUM ALLOY WITH DRILLS HAVING 45-DEG HELIX ANGLE AND VARIOUS POINT ANGLES

The records demonstrated very clearly the poor performance of the 12-deg helix flutes, as compared with those of 36-deg and 45-deg. The drill began to clog and finally broke at $^3/_8$ in. depth, under the same thrust (weight of 40 lb). Simultaneous observations of torque show the following pen records: 12-deg helix = 25 in-lb, 26-deg helix = 26 in-lb, 45-deg helix = 31 in-lb which do not differ materially.

Finally, four drills having a 45-deg helix were ground with point angles of 80, 100, 120, and 140 deg, Fig. 4. All of them reached $10 \times 5 = 50$ mm = 2 in. Under a constant feed pressure of 40 lb, the 80-deg point had the shortest operational time, i.e., 1.1 sec for drilling, and 1 sec for return. The 100-deg drill had the longest life, with 1.4 + 1.0 = 2.4 sec total time for a drilling operation.

These favorable results have been applied for more than 10 years. They are now confirmed and improved upon by using polished flutes as in the investigations reported by Gilbert and Lennie.

G. SCHLESINGER.[9]

[9] Leicestershire, England.

War Rubber Problem

TO THE EDITOR:

The article "War Rubber Problem of the United States," by A. V. Karpov,[10] gives an excellent general review of the present rubber problem. There has been much unnecessary controversy as to whether butadiene should be made from alcohol or from petroleum products.

For war purposes, the main questions are: Which types of plants can be erected more quickly and which require a minimum amount of critical materials? Consideration of these factors definitely gives certain advantages to the alcohol process. Alcohol when passed over the proper catalyst at the optimum temperature is converted into gases to the extent of 60 to 75 per cent in a single pass. The unconverted alcohol is easily separated from the gas mixture and recovered for recycling through the catalyst. The gases consist of hydrogen, ethylene, butadiene, and a small amount of butylene, so that by a combination of refrigeration and compression the hydrogen and ethylene are separated from the liquid butadiene-butylene which contains about 85 per cent butadiene.

The final purification of butadiene is effected by means of selective solvents. It is thus evident that a gas exceedingly rich in butadiene is obtained without undue difficulty and without the use of excessive amounts of equipment.

In processes involving petroleum, butadiene is usually first formed in relatively low concentrations (5–20 per cent). It must be separated from impurities which have distillation ranges close to that of butadiene and after a number of steps a butylene-butadiene mixture which may contain about 40 per cent of the former is obtained. The processes of obtaining pure butadiene from butylene are, of course, the same as those which are used for separating these products obtained from alcohol. Because of the greater dilution of the butadiene, larger purification equipment is needed for the butadiene obtained from petroleum. Much of the equipment needed for the petroleum process is made of alloy steel, thus involving large amounts of very critical nonferrous metals.

The aforementioned points indicate why so much more critical materials are required for the construction of a petroleum butadiene plant than for one which uses alcohol. As a result of the larger equipment requirements, plants for utilizing the petroleum process require a greater time to erect.

The distilling industry has been converted to the production of industrial alcohol. In accordance with the recommendations of the Baruch report, plants having a combined capacity of 100,000,000 gal per year of 190-proof ethyl alcohol have recently been approved. These new plants together with the present output of converted distilleries and industrial-alcohol producers should supply more than enough alcohol for all war needs, including synthetic rubber.

An alcohol plant when properly engineered requires a minimum amount of critical metals. The fermenters can be of wood; equipment required for cooking the mash can be reduced to a small part of that previously needed for this purpose by using continuous cookers. Stills can be made of steel instead of copper and can be packed with raschig rings in place of the usual bubble cap plates.

From a cost standpoint under present circumstances, butadiene produced from petroleum should be substantially cheaper than that produced from alcohol. The price of alcohol is about 50 cents per gallon and the butadiene yield from alcohol is 2.2 to 2.5 lb per gal of alcohol. However, under war conditions the cost of a product is much less important than the speed with which it can be obtained.

After the war when the production price of alcohol again returns to normal, there are many reasons for believing that the cost of butadiene produced from it will be in line with that which is made from petroleum. Therefore it can be expected that we shall have a synthetic-rubber industry in this country based on butadiene, the sources of which will be both petroleum and certain agricultural products.

C. L. GABRIEL.[11]

[10] MECHANICAL ENGINEERING, vol. 65, 1943, pp. 179–181.

[11] Vice-President, Publicker Commercial Alcohol Co., Philadelphia, Pa.

A.S.M.E. BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code is requested to communicate with the Committee Secretary, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of March 26, 1943, subsequently approved by the Council of the Society.

CASE No. 977 (Reopened)

(Special Ruling)

Inquiry: Is it permissible under the Code requirements to use material complying with A.S.T.M. Specifications A226-40 for Electric-Resistance-Welded Steel Boiler and Superheater Tubes for High-Pressure Service, and EA-A226, on the same basis as Specification S-32?

Reply: It is the opinion of the Committee that material complying with A.S.T.M. Specifications A226-40 and EA-A226 may be used where provision is made for the use of material complying with Specification S-32.

CASE No. 983 (Reopened)

(Special Ruling)

Inquiry: In view of the restrictions affecting the availability of the usual grades of bolting material, will the following additions and extensions of Tables P-7 and U-2 meet the intent of the Code?

(*1*) Heat-treated carbon steel bolting materials;

(2) Manganese steel bolting material;

(3) Bolting steels to suitable National Emergency specifications;

(*4*) Increase of temperature limit on type B7 of A.S.T.M. Specifications A193-40T to 1000 F.

Reply: Certain of the steels listed are new, and complete data as to the high temperature strengths are not available, making it necessary for the Committee to exercise judgment in establishing the acceptability of these substitutes. It is the opinion of the Committee that the following additions and extensions of Tables P-7 and U-2 are conservative, based on the advice of the Subcommittee on Ferrous Materials and other competent metallurgical experts, and may be accepted as meeting the intent of the Code:

(*1*) Medium-carbon steel of SAE 1000 series, with a silicon content of 0.10 per cent minimum, heat-treated to meet the requirements of Specification S-9, Class A, or heat-treated carbon steel furnished to the following minimum physical property requirements taken from A.S.T.M. Specifications A261-43T:

Tensile strength, psi 100,000
Yield point, psi 75,000
Elongation in 2 in., per cent . . 16
Reduction of area, per cent.....45

may be used as bolting with the following stresses:

—20 to 650 F	700 F	750 F	800 F	850 F
13000	11950	10000	8000	5500

NOTE: Between temperatures of —20 F to 400 F, stresses equal to the lower of the following will be permitted: 16 per cent of tensile strength; 20 per cent of yield point stress.

(2) Manganese steel of SAE 1300 series or equal, with a manganese content of 1.90 per cent maximum, is acceptable for bolting material conforming to the requirements of Specification S-9, Class A or B, whichever is specified, and may be used with the same allowable stresses, respectively, as given in Tables P-7 and U-2.

(3) The following National Emergency steels are acceptable and may be used at the same stresses as are permitted for A.S.T.M. Specifications A193-40T, Grades B7 and B7a bolting:

B7	B7a
NE 8339	NE 8547
NE 8442	NE 8949
NE 8447	
NE 8739	
NE 8744	

(*4*) Bolting steels complying with A.S.T.M. Specifications A193-40T, Grade B7, and the alternate NE steels may be used to 1000 F with the following stresses for the extended temperatures:

950 F	1000F
6800	3600

(5) Note 11 of Tables P-7 and U-2 shall apply to all the above allowable stresses.

CASE No. 994

(Special Ruling)

Inquiry: Will unfired pressure vessels fabricated by fusion welding under the requirements of Pars. U-69 and U-70 meet the intent of the Code if the base material is aluminum-manganese alloy conforming to Specification S-39?

Reply: It is the opinion of the Committee that aluminum-manganese alloy plate and sheets conforming to Specification S-39 may be used for the construction of unfired pressure vessels under the general requirements of Pars. U-69 and U-70. For vessels constructed under either of these paragraphs, the welding requirements of Par. U-69 and Section IX shall apply except that:

(*1*) The elongation as determined by the free-bend test shall be not less than 25 per cent;

(2) The rules of Par. U-20 shall be applied using the values in Table U-3 for annealed material for the allowable working stress multiplied by:

(*a*) For Par. U-69 construction, 80 per cent joint efficiency;

(*b*) For Par. U-70 construction, the ratio of SE values given in Par. U-70(*a*) divided by 11,000.

(3) Stress relieving is not required for wall thicknesses up to and including $1^1/_8$ in. thickness of the shell;

(*4*) The tensile strength of a reduced-section tension specimen shall be not less than 85 per cent of the minimum specified tensile strength of quarter-hard or as-rolled plate and not less than 95 per cent of the minimum specified tensile strength of annealed plate.

CASE No. 996

(Interpretation of Pars. P-102h, U-68h)

Inquiry: Will welded joint reinforcements exceeding the limitation specified in Pars. P-102(*h*) and U-68(*h*) be acceptable in Code construction?

Reply: It is the opinion of the Committee that, in view of the experience available and the advancement of the technique of radiographic examination, provided that all other requirements of Pars. P-102(*h*) and U-68(*h*) are met, the following limitations of weld reinforcement may be used:

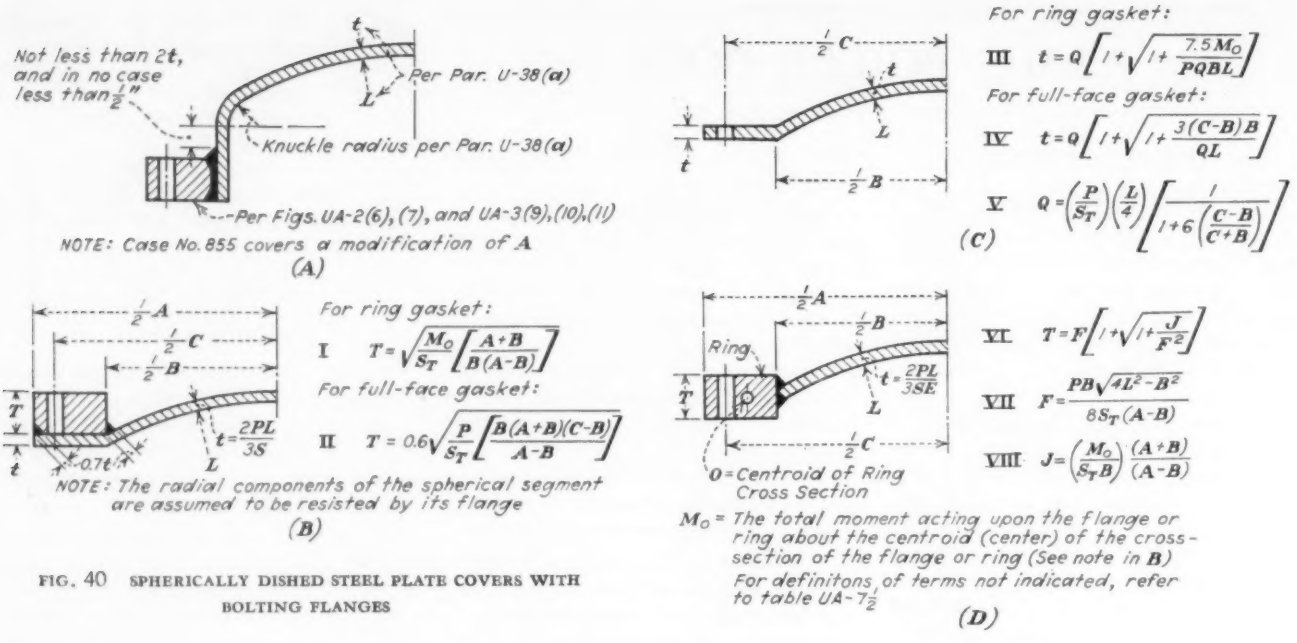

Not less than 2t, and in no case less than 1/2"
Per Par. U-38(a)
Knuckle radius per Par. U-38(a)
Per Figs. UA-2(6), (7), and UA-3(9), (10), (11)
NOTE: Case No. 855 covers a modification of A
(A)
For ring gasket:
I T = √(M_O/S_T [(A+B)/(B(A-B))])
For full-face gasket:
II T = 0.6√(P/S_T [B(A+B)(C-B)/(A-B)])
t = 2PL/3S
0.7t
NOTE: The radial components of the spherical segment are assumed to be resisted by its flange
(B)
For ring gasket:
III t = Q[1 + √(1 + 7.5M_O/PQBL)]
For full-face gasket:
IV t = Q[1 + √(1 + 3(C-B)B/QL)]
V Q = (P/S_T)(L/4) / [1 + 6((C-B)/(C+B))]
(C)
Ring
t = 2PL/3SE
O = Centroid of Ring Cross Section
VI T = F[1 + √(1 + J/F²)]
VII F = PB√(4L²-B²) / 8S_T(A-B)
VIII J = (M_O/S_T B)((A+B)/(A-B))
M_O = The total moment acting upon the flange or ring about the centroid (center) of the cross-section of the flange or ring (See note in B)
For definitons of terms not indicated, refer to table UA-7 1/2
(D)

FIG. 40 SPHERICALLY DISHED STEEL PLATE COVERS WITH BOLTING FLANGES

Plate thickness, in.	Thickness of reinforcement, in.
Up to 1/2, incl.	1/16 maximum
Over 1/2 to 1, incl.	1/16 to 3/32
Over 1	3/32 to 1/8

CASE No. 997

(Special Ruling)

Inquiry: Is it permissible to use circular spherically dished heads with bolting flanges (dished cover plates) for heads concave to the pressure?

Reply: It is the opinion of the Committee that heads of the types illustrated herein fabricated from materials recognized as weldable by the Code may be used provided they are designed to meet the requirements indicated in Fig. 40. The thickness of the flange for (*A*) and (*B*) shall be calculated by the appropriate formula as indicated on the figure, except that within the range of the American Standard (B16e-1939) for Steel Pipe Flanges and Flanged Fittings, the flange facings and drillings shall conform to that Standard and the thickness specified therein shall be considered as minimum requirement. Off-size flanges within the American Standard range may be computed by interpolation. Heads shown in (*C*) and (*D*) shall be designed for all sizes by the formulas given.

CASE No. 998

(Interpretation of Par. U-69a)

Inquiry: May the proposed revision of Par. U-69(*a*), modifying the pressure-temperature service limitations for Par. U-69 vessels, as published in the February, 1943, issue of MECHANICAL ENGINEERING, be made effective immediately?

Reply: Since no adverse comment has been received and no changes are indicated in the proposed revision of Par. U-69(*a*), it is the opinion of the committee that the following revised form of this paragraph may be used in place of the present form pending the issuance of the customary schedule of revisions in the form of addenda sheets:

"U-69(*a*) All vessels covered by this Code when constructed in accordance with the rules of this paragraph, and when the plate thickness of the shells and of the heads fabricated of more than one piece do not exceed 1 1/2 in. at the joint, may be used for any purpose and under any operating conditions with the following exceptions:

Par. U-69 vessels may not be used:

(1) To contain lethal substances, either gases or liquids;

(2) For operating pressures exceeding 600 psi.

The limit of plate thickness does not apply to heads formed of a single plate. The pressure limitation does not apply to vessels operating under hydrostatic pressure at atmospheric temperatures."

Case No. 968

Reopened

As a result of numerous comments received since its adoption at the September 11, 1942, meeting of the Boiler Code Committee, Case No. 968 has been revised, primarily for the purpose of clarification. One notable change which has been made is that shells, the thicknesses of which exceed 1/2 in., but are less than 10 per cent of the inside radius, are to be determined by the formula in Par. P-180(*b*) rather than by the formula in Par. P-180(*a*). The reason for the use of the formula in Par. P-180(*b*) for the entire range of shell thicknesses exceeding 1/2 in. is that it will eliminate the appreciable difference in the required shell thickness now obtained at $t = .10R$ by the two formulas.

The revised wording of this Case is published here for comments only and those interested are invited to submit their comments to the Secretary of the Boiler Code Committee at the Society headquarters, 29 West 39th St., New York, N. Y., to be received not later than June 10, 1943.

A corresponding revision of Case No. 979 along the same lines is contemplated.

CASE No. 968 (*Reopened*)

Inquiry: Due to improvements in design, construction, and materials, may the design stresses for power-boiler pressure parts and the joint efficiency in fusion-welded construction be increased over present Code requirements?

Reply: It is the opinion of the Committee that the existing Code rules shall be complied with except as herein modified.

The maximum allowable working pressure for welded or seamless drums and headers of power boilers and for tubes used in water-tube boilers may be determined as follows:

(*A*) Drums, headers, and heads of power boilers, with a thickness not exceeding 1/2 in., shall be constructed by using formulas in Pars. P-180(*a*), P-195, P-198, and P-268(*a*), with maximum design stresses given in Table P-7, and, if welded, a joint efficiency of 95 per cent may be used.

(*B*) Drums, headers, and heads of power boilers with thicknesses exceeding 1/2 in. may be constructed by using formulas in Pars. P-180(*b*), P-195, P-198 and P-268 with maximum design stresses given in Table P-7 multiplied by 1.25 and with 0.10 in. added to the calculated

thickness, and if welded, a joint efficiency of 95 per cent may be used, with the following restrictions:

(1) The weld reinforcements shall be removed flush with the surface of the plate. In cases where plates of unequal thicknesses are abutted, the edge of the thicker plate shall be reduced by a taper of not less than 4 to 1. Other joint details shall conform with the requirements of Par. P-104.

(2) Stresses due to hydrostatic head shall be taken into account in determining the thickness to be used; also the total of other stresses due to loads, such as the weight of drums, tubes, water, and distances between drum supports, if these stresses increase the average stress over substantial sections of the shell or head by more than 10 per cent.

(3) For pressures 400 lb and over, the feedwater and lower water column connections shall be so provided with shields, sleeves, or other suitable means to reduce the effect of temperature differentials.

(4) The increased design stresses as defined in this Case may be used only for flat heads and for hemispherical or ellipsoidal heads with pressure on the concave side.

(5) The following parts shall be designed in accordance with the present rules of the Code, but they may be used with shells which are constructed in accordance with the rules of this case:

(*a*) Dished heads, other than hemisperical or ellipsoidal;

(*b*) All unstayed dished heads with pressure on the convex side;

(*c*) Ellipsoidal heads with flanged-in and otherwise unreinforced manholes;

(*d*) All stays, braces, and parts requiring staying.

(6) Openings in the shell requiring reinforcement under Par. P-268 shall have the reinforcement applied uniformly on the inside and outside of the shell. If not so applied, the amount of reinforcement shall be calculated for a required shell thickness using design stresses from Table P-7. Openings in the heads may have reinforcement on the outside only.

In determining the maximum size of an unreinforced opening under Par. P-268(*a*) the value of *K* to be used in connection with the chart in Fig. P-35 shall be 1.1 times the value of *K* computed by the formula of that paragraph for the part of the shell that contains the opening. When computing *K* by the formula in Par. P-268(*a*) the pressure *P* shall be that for which the boiler is designed, *S* shall be 1.25 times the value from Table P-7, and *t* shall be the actual full thickness of the shell at the location of the opening, including the 0.10 in. additive thickness. Where *K*, so computed, is unity or greater, the maximum size of unreinforced opening shall be 2 in.

(7) Welded vessels constructed under these alternate rules shall be stress-relieved in accordance with Par. P-108, with the additional provision that vessels shall be allowed to cool slowly in a still atmosphere to a temperature not exceeding 600 F.

(8) When the increase in maximum stress as set forth under (*B*) is used in the construction of shells and heads of boiler drums and of headers, the hydrostatic test pressure shall be at least, but need not exceed 1.5 times the maximum allowable working pressure.

(*C*) The maximum allowable working pressure for tubes for water-tube boilers used in this Case, may be determined by multiplying the stress value in the formula accompanying Table P-2 by 1.25, but from the pressure so calculated, 30 psi shall be deducted.

(*D*) Boilers constructed in accordance with the requirements of this Case, and other applicable Code Rules are considered safe and shall be stamped in accordance with Par. P-332, the Code symbol stamp to be followed by the letter "A," which also shall be shown on the manufacturer's data report.

Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published below with the corresponding paragraph number to identify their location in the various sections of the code and are submitted for criticism and approval from anyone interested therein.

It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Committee for consideration.

PARS. P-102(*g*), L-102(*g*), U-68(*g*). Revise first sections to read:

Should any of the tests fail to meet the requirements by more than 10 per cent, no retests shall be allowed EXCEPT THAT IN THE CASE OF FAILURE OF THE FREE-BEND TEST SPECIMEN DUE TO PERMISSIBLE DEFECTS, FREE-BEND SPECIMEN RETESTS MAY BE ALLOWED AT THE DISCRETION OF THE INSPECTOR.

PARS. P-102(*b*) (1*b*), (2*b*); L-102(*b*) (1*b*), (2*b*); U-68(*b*) (1*b*), (2*b*):

(1*b*) Welds in which the radiographs show elongated slag inclusions, OR cavities EXCEEDING THE PERMISSIBLE LIMITS, OR ZONES OF INCOMPLETE FUSION shall be unacceptable, etc.

(2*b*) Welds in which the radiographs show any type of crack [or zones of incomplete fusion] shall be unacceptable.

PAR. P-180. Revise to read:

(*a*) The maximum allowable working pressure on the shell of a boiler or drum shall be determined by the strength of the weakest course, computed from the thickness of the plate, the efficiency of the longitudinal joint, or of the ligaments between the tube holes in shell or drum (whichever is the least), the inside radius of the course, and the maximum allowable unit working stress.

$$P = \frac{SEt}{R+0.6t} \quad \text{or} \quad t = \frac{PR}{SE-0.6P}$$

where

P = maximum allowable working pressure, psi,
S = maximum allowable unit working stress, psi, taken from Table P-7,
t = minimum thickness of shell plates in weakest course, in.,
E = efficiency of longitudinal joints or of ligaments between openings:
for riveted joints = calculated riveted efficiency,
for fusion-welded joints = efficiency specified in Par. P-102,
for seamless shells = 100 per cent,
for ligaments between openings, the efficiency shall be calculated by the rules given in Pars. P-192 and P-193.
R = inside radius of the weakest course of the shell or drum, in.

(*b*) Present (*b*) to be deleted.

(*c*) This will become (*b*).

PAR. A-125. To be deleted.

PAR. U-20(*a*) AND (*b*). Revise to read:

(*a*) *Shells for Internal Pressure.* The maximum allowable working pressure on the shell of a pressure vessel shall be determined by the strength of the weakest course relative to the loads upon it computed from the thickness of the plate, the efficiency of the longitudinal joint or of the ligament between openings (whichever is the least), the inside radius of the course, and the maximum allowable unit working stress.

$$P = \frac{SEt}{R+0.6t} \quad \text{or} \quad t = \frac{PR}{SE-0.6P}$$

where

P = maximum allowable working pressure, psi,
S = maximum allowable unit working stress, psi, taken from Tables U-2 and U-3,
t = minimum thickness of shell plates in weakest course, in.,
E = efficiency of longitudinal joints or of ligaments between openings:
for riveted joints = calculated riveted efficiency,
for fusion-welded joints = efficiency specified in Pars. U-68, U-69, and U-70,

for seamless shells = 100 per cent,
for ligaments between openings, the efficiency shall be calculated by the rules given in Pars. P-192 and P-193.

R = inside radius of the weakest course of the shell, in.

When a shell is made of any of the welded tubing or piping enumerated in Pars. U-13(*e*), the factor SE shall be as given in Table U-2 1/2.

The maximum allowable working pressure for shells other than cylindrical or spherical, and for heads and other parts, shall be determined in a similar manner using the formulas appropriate for the parts, as otherwise given in the Code.

(*b*) Where the thickness of the shell of a wholly spherical vessel does not exceed 20 per cent of the inside radius, the maximum allowable working pressure in the shell of the pressure vessel shall be computed by the formula:

$$P = \frac{2tSE}{R} \qquad t = \frac{PR}{2SE}$$

The symbols are as defined in (*a*) except that R is to be the inside radius of the sphere in all cases and E the efficiency of any joint or of ligaments between openings.

(Present (*b*) to be deleted.)

PAR. UA-100. To be deleted.

PAR. P-299(*e*). Modify the proposed new second section to read:

Valves and fittings otherwise complying with the requirements of the American Standard, but having butt welding ends, may be rated at the pressures stated in that Standard for ring joints (See Table P-15), PROVIDED ALSO THAT ALL PARTS OF THE VALVES ARE SUITABLE FOR THE PRESSURE AT WHICH THEY ARE USED.

PAR. L-102(*b*). The proposed addition to the seventh section of Par. P-102(*b*) as shown in May, 1943, MECHANICAL ENGINEERING to be added to the seventh section of Par. L-102(*b*).

PAR. L-102(*b*) (1*a*). The proposed revision of the fourth section of Par. P-102(*b*) (1*a*) as shown in May, 1943, MECHANICAL ENGINEERING to be made in the fourth section of Par. L-102(*b*) (1*a*).

PAR. L-105(*c*). This paragraph to be revised to correspond with the proposed revision of Par. P-105(*c*) as shown in May, 1943, MECHANICAL ENGINEERING.

PAR. L-107(*c*). An addition will be made to this paragraph as item (*4*) to correspond to the proposed addition as item (*3*) of Par. P-108(*c*) as shown in May, 1943, MECHANICAL ENGINEERING.

FIG. L-14. This figure to be revised to correspond with the proposed revision of Fig. P-36 as shown in May, 1943, MECHANICAL ENGINEERING.

PAR. U-13(*g*). Add the following:

(7) Screwed fittings of cast iron or malleable iron, and conforming to the requirements of the Standards for 125, 150, 250, and 300 lb pressure as referred to in Table UA-5 1/2 in the Appendix, may be used except where otherwise specifically prohibited or where flanged fittings are specifically required. They shall not be used for temperatures over 450 F.

TABLE UA-5 1/2. This will be the same as Table A-11.

PAR. U-76(*b*). Revise to read:

Unless otherwise limited by the provisions of Par. U-13(*e*), vessels constructed in accordance with Par. U-69 shall be stress-relieved where the thickness exceeds 1 1/4 in., or where the diameter is less than that determined by the formula $d = 120t - 50$, where d is the inside diameter in in., t the shell thickness in in. Vessels having a wall thickness less than 0.58 in. need not be stress-relieved regardless of diameter.

U-76(*c*). Revise first sentence to read:

Where stress relieving is required it shall be done by heating uniformly to at least 1100 F BUT NOT OVER [and up to] 1200 F [or higher] UNLESS THE CHARACTERISTICS OF THE MATERIAL REQUIRE A HIGHER TEMPERATURE FOR PROPER STRESS RELIEVING [if this can be done without distortion.]

TABLES P-5, P-7, U-2, U-2 1/2. Add the following:

TABLES U-2 AND P-7

Specification number	Grade	Stress at 1000 F
PLATE STEELS		
Carbon Steels		
S-1	..	1350
S-2	A	1350
S-2	B	1350
S-53	A (firebox)	1350
S-53	B (firebox)	1350
PIPES AND TUBES		
Seamless Carbon Steel		
S-17	A	1350
S-18	A	1350
S-18	B	1350
Electric-Resistance-Welded		
S-32	A	1350
S-32	C	1350
S-58	A	1350
S-58	B	1350
Fusion-Welded		
S-1	..	1350
S-2	B	1350
S-2	A	1350
FORGINGS		
Carbon Steels		
S-8	1	1350
S-8	2	1350
S-10	A	1350
S-10	B	1350
S-10	C	1350
S-50	1	1350
S-50	2	1350
CASTINGS		
Carbon steel		
S-11	B, B2	1350

TABLE P-5

Specification number	Grade	Stress at 1000 F
Seamless Carbon Steel		
S-17	A	1350
S-18	A	1350
S-18	B	1350
Electric-Resistance-Welded		
S-32	A	1150
S-32	C	1150
S-58	A	1150
S-58	B	1150
Fusion-Welded		
S-1	...	1200
S-2	B	1200
S-2	A	1200
Seamless Alloy Steel		
S-48	Tl	5000
S-48	Tla	5000

TABLE U-2 1/2

Specification number	Grade	Weld	Stress at 1000 F
S-32	A, silicon, .10%	Resistance	1700
S-32	A	Resistance	1150
S-32	C, silicon, .10%	Resistance	1700
S-32	C	Resistance	1150
S-40	A	...	2000
S-45	Pl	...	5000
S-49	..	...	2000
S-48	Tl	...	5000
S-48	Tla	...	5000
S-58	A, silicon, .10%	Resistance	1700
S-58	A	Resistance	1150
S-58	B, silicon, .10%	Resistance	1700
S-58	B	Resistance	1150

PAR. U-142(*f*). Replace the first and second sentences by the following:

The length of the impact bar shall be taken parallel to the direction of the expected maximum stress for both seamless and welded containers.

FIG. U-15. In the two sketches in (*b*), delete the words "not less than 2T and in no case less than 1/2 in.," and the dimension lines.

PAR. U-73(*d*). Omit last sentence.

PAR. UA-21(*b*). Add the following as the second section:

For Par. U-68 vessels the requirements of Par. U-68(*b*) shall apply to the construction shown in Fig. UA-3(9); otherwise radiographic examination of the welds in these figures may be omitted.

PAR. UA-21(*a*)(*1*). Add the following note:

NOTE: At the option of the designer, the flanges shown in Figs. UA-2(6) and (7) may be designed on the assumption that they act as integral flanges and the stress calculations shall comply with the requirements of Pars. UA-23(*a*) and UA-24(1).

FIG. UA-3(*10*). Delete the throat dimension $0.7g_0$ (min) of the fillet weld at the back of the flange; reduce the size of the fillet weld on the drawing; dimension one leg of the fillet weld as follows:

$0.25g_0$ but not less than 3/16 in., the minimum for either leg. This weld may be machined to a corner radius as permitted in detail (*8*).

FIG. UA-2. The above modified form of Fig. UA-3(*10*) to be added as Fig. UA-2(*7d*), and reference thereto to be made in Par. UA-21(*a*).

A.S.T.M. SPECIFICATIONS A214-42. This will be incorporated in Section II of the code.

A.S.T.M. SPECIFICATIONS A226-40 (S-68) AND A214-42 (S-69): Reference to these specifications will be made in the first and second sections of

Par. U-13(*e*), Pars. P-3, P-11, P-21(*a*), and Note 4 of Table P-2. The following stresses for these materials will be added to Tables P-7 and U-2; and Tables P-5 and U-2½:

TABLES P-7 AND U-2: Under the heading "Electric-Resistance-Welded Pipes and Tubes:"

Spec. no.	Spec. min tensile	Notes and limitations	—20 to 650 F	700	750	800	850	900	950	1000
S-68	None	(3), (4)	9400	9000	8600	7900	6800	5600	3800	2000
S-68, S-69	None	(4)	9400	9000	8150	7150	5850	4400	2600	1350

TABLES P-5 AND U-2½: Under the heading "Electric-Resistance-Welded Pipes and Tubes:"

		Min si								
S-68	None	0.10	(4)	8000	7650	7300	6700	5800	4750	3250	1700
S-68, S-69	None	..	...	8000	7650	6950	6100	4950	3750	2200	1150

MATERIAL SPECIFICATIONS, SECTION II: The following specifications will be revised to bring them up to date with the latest A.S.T.M. Specifications: S-21, B12-42; S-24, B43-42; S-37, B98-42; S-38, B25-42T; S-39, B126-42T; S-41, B11-42; S-59, B57 to be dropped, replaced by S-67; S-1, A70-42; S-13, A48-41; S-33, A157-42; S-33, A157-42; S-56, A216-42T; S-57, A217-42T; S-37, A158-42T; S-45, A206-42T; S-43, A203-42; S-44, A204-42; S-64, A249-42; editorial changes will be made in S-18, S-9, S-40, S-58 to bring them up to date with the latest A.S.T.M. Specifications; A261-43T will be added as S-70, and the following stresses will be added to Tables P-7 and U-2:

—20 to 650 F	700 F	750 F	800 F	850 F
13000	11950	10000	8000	5500

SPECIFICATION S-18. The Note in parentheses to be changed to read: (Based on A.S.T.M. Specifications A53-42.) The note preceding Par. 1 which refers to A.S.T.M. Specifications A106-41 will be deleted; In Par. 3, the line reading: "Acid bessemer . . . 0.11" to be deleted; Par. 2(*a*), second sentence, will be revised to read:

The steel for seamless or electric-resistance-welded pipe shall be made by THE open-hearth OR electric-furnace PROCESS.

The last sentence of Par. 4 will be deleted; in Par. 17 the words "where acid-bessemer steel is used in seamless or electric-resistance-welded pipe, the word 'bessemer' shall be added before the letter *A* or *B*," will be deleted.

A.S.T.M. SPECIFICATIONS A106-42T (S-71). This will be adopted with the following modifications: The second sentence of Par. 2(*a*) will be revised to read:

All seamless pipe shall be made of killed steel by one or more of the following processes: open-hearth or electric-furnace.

Note *a* in Table 1 will be deleted; In Par. 17 the words "where acid-bessemer steel is used, the word bessemer shall be added, that is, seamless bessemer *A* or seamless bessemer *B*," to be deleted.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

World Minerals and World Peace

WORLD MINERALS AND WORLD PEACE. By C. K. Leith, J. W. Furness, and Cleona Lewis. The Brookings Institution, Washington, D. C., 1943. Cloth, 6 × 9 in., 251 pp., illus., $2.50.

REVIEWED BY WALTER R. INGALLS[1]

THIS is an important publication. Dr. Leith, its leading author, professor of geology in the University of Wisconsin and holding a high position as a governmental consultant in Washington, has made the study of international control of minerals a specialty during many years. Mr. J. W. Furness, mining engineer, was chief of the economics and statistics branch of the U. S. Bureau of Mines until his retirement in 1940. Dr. Cleona Lewis is the author of several of the publications of The Brookings Institution in the field of international economic relations.

The geopolitical thesis of the present book is that potential world control is not necessarily afforded by control of any of the great land masses, but that it lies in the control of mineral resources, wherever they are, backed up by control of the air and the sea.

This subject is manifestly interwoven with Article IV of the Atlantic Charter, which pledges in a general way that after the present war all nations shall have free access to the natural resources of the world. Many have been unable to understand the meaning of this pledge. Have not all nations, prior to the present war, been able to acquire by purchase all of the raw materials for which they could pay? Germany was one of our large and welcomed customers for copper. We gladly let the Japanese have great quantities of copper and steel scrap, and they got much lead and zinc from Mexico. We got tin, rubber, jute, hemp, and other things from the Orient. And so on.

Herbert Feis, an economic adviser to the U. S. Department of State, in a speech April 19, 1943, as quoted in the newspapers, proposed that rich countries share their natural resources with the poor and among other things disallow monopolistic restraints and agree not to impede the export of their raw materials. He remarked that most of the plans for sharing the natural resources call for setting up a pool from which raw materials could be distributed among nations on the basis of need rather than ability to pay. All of this sounds futile. Leith, Furness, and Lewis are better informed and wiser.

The first part of their book is devoted to a statistical survey, together with considerable explanation and interpretation. As to the statistics, Mr. Furness knows that subject, but it might be wished that he and his co-authors were better acquainted with the commerce and technology that have led to the prewar situations. Also I wish that they had emancipated themselves from certain fallacies that still prevail in statistical circles in Washington. One of these has to do with the subject of metallic scrap (pp. 11 and 19). Another, prevailing in some political circles, is concerned with the mischief that cartels and monopolies are supposed to have done. The authors of the present work in their chapter 7 are rather tart in some of their comments and not always historically accurate. Later in their work they hold the cartels, etc. to have been substantially blameless. However, this criticism has to do with what are only minor flaw·. It is the latter portion of their work beginning with page 186 that is most important. In chapter 11, on "Access to Raw Materials," they ask and answer a series of questions, as follows, the answers being my condensations and the interpolations in brackets being my own:

Q. Are the so-called have-not nations poor in mineral raw materials? A. Yes.

Q. Have the poorly endowed nations been denied access to world's supplies of raw materials? A. No, except in times of war.

Q. Why is access on an equal cost basis impossible? A. Because of differences in geographic positions, transportation, transportation costs, etc.

[1] Consulting Engineer, New York, N. Y.

Q. Have international cartels and corporate monopolies discriminated against the poorly endowed nations? A. Only a few discriminations against any country in peacetime. (The authors add that one of the two notable cases is the difference in the prices charged by the German potash cartel.)

Q. Have trade barriers impeded the flow of minerals to poorly endowed nations? A. There has been only one positive restriction on the export of mineral raw materials, viz., helium from the United States in 1938. (For which there was a good reason.) Further on the authors say "our conclusion is that the removal of trade barriers to the international flow of minerals would be only a minor contribution to the solution of the problem of equal access to world resources."

Q. Why is it assumed that a nation gains special advantages from political control of mineral producing areas? A. It may be granted that there are certain limited advantages in the control of colonies. (Some will think that the authors underestimate these.)

Q. Is the primary argument for control of raw materials, however much concealed, their strategic importance in time of war? A. Yes, "here is the key to most of the complaints by the have-not nations."

Q. What are the implications of the Atlantic Charter in regard to raw materials? A. So long as minerals are required for economic prosperity, says the charter, they are to be freely available to all through the mechanism of trade. (Which was so prior to the war, except as to helium.)

The final chapter of the book is concerned with policy and was prepared by Dr. Leith alone. He comes to the conclusion that all nations must have unrestricted access to raw materials *for purposes of peace*, but not *for purposes of war*. He thinks that the Atlantic Charter foreshadows the adoption of a mineral control policy, but does not provide a plan for putting it into effect. Dr. Leith from his long experience reviews proposals and some measures put into effect, since the end of World War I, and shows how they failed to work. He does not now offer any plan but suggests that there will have to be a good deal of nationalization, and a good deal of policing, and a good deal of supervision, etc., the idea of which makes us shudder when we think of WPB, OPA, etc. However, he is convinced that private initiative is necessary in the complex field of finding and utilizing mineral resources. Would it be necessary to forego these advantages in favor of complete nationalization of these resources? Dr. Leith thinks tentatively that a middle course must be found between the extremes of nationalization and *laissez faire*.

I should not say from anything in this chapter that Dr. Leith has committed himself to nationalization as a necessary evil (if anyone wants to put it that way). The book that has come out under his leadership is broad-minded and stimulating. The authors outline a good deal of essential fact and offer some guidance without presenting and advocating any plan of their own. They point out that the time is drawing near when we shall need to have a plan ready or be prepared to discuss proposals. There is the assumption of unconditional surrender by the Axis powers.

Science Remakes the World

SCIENCE REMAKES THE WORLD. By James Stokley. Ives-Washburn, Inc., New York, N. Y., 1942. Cloth, $5^3/_4 \times 8^3/_4$ in., 298 pp., 35 illus., $3.50.

REVIEWED BY R. L. SACKETT[2]

THERE is the oft-told story of Faraday, who was asked by Gladstone what use his discovery of electromagnetic induction would have. In reply, the scientist asked the statesman: "What use is a baby?" This book displays some of the fingers, ears, eyes, and brains of the baby, Science, in an attractive form.

This book of less than 300 pages, plus fine photographs, which digests 20 subjects from atoms to vitamins in a scientific, but readable, understandable text deserves attention.

Chapter subjects include atoms, explosives, fuel, plastics, chemical clothes, rubber, chemistry and the farmer, chemicals for cures, new metals, mining the ocean, the magic of glass, aeronautics, electrons, radio, light, television, power, vitamins.

The author is technical-book editor of the *New York Herald Tribune*, former director of The Franklin Institute, Philadelphia, and of the Institute of Popular Science, Pittsburgh. He called upon and received aid from 35 leading scientists representing the fields of science which the author has illuminated by searchlight.

Two hundred years ago, Reaumur, a Frenchman, investigated spider webs, silkworms, and silk. He said "Silk is only a liquid gum which has been dried; could we not make silk ourselves with gums and resins?" The chapter on chemical clothes tells the answer. Celluloid, cellophane, rayon, nylon, koroseal, "wool which gives moths indigestion," and other synthetics are the result.

Take chapter 14, the age of electrons, as an example. It is naturally considered to be a difficult subject to comprehend technically and in its rapidly expanding scope. The author has made it accurate, inspiring, and clear to any who have a genuine interest in science.

The development of electronics is traced from Hertz to Roentgen, to Crookes, to J. J. Thomson, to Edison, de Forest, Langmuir, Einstein, Coolidge, and others. It is history in a fabric which connects the threads of development in an entrancing and informing pattern.

The treatment of the atom in chapter 19 is equally clear and a complex subject is pictured by the precise use of common words and by photos. New sources of power explore heat from the sun's rays and from other rare possibilities including "atom smashing."

The book adds to our available digested scientific knowledge and is a lode to mine for those interested in the significance of science to society.

[2] Assistant to the Secretary, A.S.M.E. Dean Emeritus of Engineering, The Pennsylvania State College. Fellow, A.S.M.E.

Books Received in Library

AIR NAVIGATION. By E. R. Hamilton. Ronald Press Co., New York, N. Y., 1943. Cloth, 5 × 8 in., 175 pp., diagrams, charts, tables, maps, $2. The aim of this book is to meet the needs of those who, with no previous knowledge of the subject, wish to acquire a working knowledge of air navigation in a somewhat limited time. With this aim in view, the essentials of the subject are described in a straightforward manner, bearing in mind the desire of the reader to become a pilot, navigator, or observer. The book is based on experience in teaching men in the Royal Air Force or preparing to enter it.

AIR NEWS YEARBOOK, edited by P. Andrews. Duell, Sloan & Pearce, Inc., New York, N. Y., 1942. Cloth, $9^1/_2 \times 12$ in., 264 pp., illus., $3.75. The Yearbook contains over three hundred and fifty photographs of airplanes, selected from the files of news agencies and aeronautical photographers. The photographs include specimens of the current fighting planes of the United States, Great Britain, Russia, China, Germany, Japan, and Italy, accompanied by technical data on each plane and by concise accounts of the organization of the various air forces.

A.S.T.M. STANDARDS ON RUBBER PRODUCTS, prepared by A.S.T.M. Committee D-11 on Rubber Products. Methods of Testing Specifications. February, 1943. American Society for Testing Materials, Philadelphia, Pa. Paper, 6 × 9 in., 301 pp., illus., diagrams, charts, tables, $1.75. This annual brings together the standard and tentative methods of tests and specifications for rubber products which the Society has approved, together with a useful bibliography on rubber testing, thus forming a convenient reference book for the laboratory. General methods, and special ones for hose, belting, gloves, matting, tape, latex, cements, sponge, and hard rubbers, and for insulated wire and cables, are given. Emergency alternate provisions for various standard specifications are included.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

1943 A.S.M.E. Semi-Annual Meeting to Be Held in the Heart of Airplane-Building Industry, Los Angeles, Calif., June 14–17

Tentative Program of Technical Sessions Announced

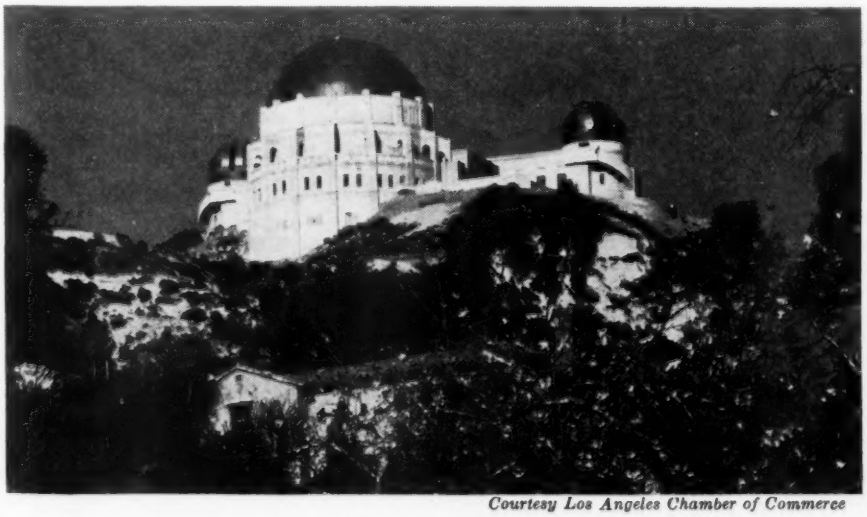
PAPERS on aviation will provide the background of the technical program of the 1943 Semi-Annual Meeting of The American Society of Mechanical Engineers, to be held in the heart of the airplane-building area of southern California, June 14–17, with headquarters at the Hotel Biltmore, Los Angeles, Calif. Co-operating with the A.S.M.E. Aviation Division in many of the sessions already announced are seven other divisions of the Society whose interests in production and manpower are closely allied.

Let Headquarters Know Your Plans

Restrictions on transportation facilities to conventions and conferences during the war period do not apply to this meeting of the Society because it is aimed entirely at the task of speeding production for victory. Government officials have indicated on numerous occasions since Pearl Harbor that the meetings of the Society have made definite contributions to the war effort. The greater attendance at all these meetings than was customary during peacetime emphasizes the value of these programs to members able to attend them. The Secretary would appreciate it if members would advise him if they have any intention of being present at the Semi-Annual meeting. The difficulties of operating a meeting from the several angles of transportation, hotel accommodations, and planning of menus for luncheons and dinners makes it more desirable than ever that members co-operate with the Secretary in this matter. This will enable him to estimate approximate attendance. One of the advantages, which members will derive by notifying the Secretary, is that special information regarding additions or changes in the program may be sent to those who do so, whereas it would not be possible to advise the entire membership.

Get Railroad Transportation at Once

Members are strongly urged that immediately upon reading this issue of MECHANICAL ENGINEERING they make their round-trip reservations as it may be more difficult to obtain desired space on the return trip than it will for the trip to Los Angeles. Attention is called to the fact that in purchasing round-trip tickets to Los Angeles one may be routed also to include a visit to San Francisco at no additional railroad fare.



Courtesy Los Angeles Chamber of Commerce

GRIFFITH OBSERVATORY

(In this imposing structure is housed one of the great telescopes of the world.)

Make Your Railroad Reservations Now!

For Los Angeles in June

IF you are planning to attend the A.S.M.E. Semi-Annual Meeting in Los Angeles, Calif., June 14–17, it is imperative that you make your railroad reservations immediately, *both ways*.

There will be no special cars or special rates as in former years. Your ticket agent should be consulted for complete information.

Do it now! Don't delay!

Make Hotel Reservations Early

Although a considerable number of rooms are being reserved by the Los Angeles Biltmore, it is believed that the technical program is so attractive that there will be a large attendance and we would urge those members desiring accommodations at the headquarters hotel to make reservations immediately. When making reservations it is very essential that time of arrival and period of stay be given.

Alien Property Custodian to Exhibit Patents at Los Angeles

In connection with the Semi-Annual Meeting of the Society at Los Angeles, the Office of Alien Property Custodian will exhibit some 30,000 patents and applications that may be of interest to engineers attending the meeting. These are United States patents which were formerly under enemy control but have now been vested by the Alien Property Custodian and are being licensed to American industry.

Plant Visits

War restrictions do not permit organized visits to industries engaged in war contracts. However, it is generally possible for members who have a direct interest in the production of a particular company to obtain permission provided they are equipped with proper identifica-

Courtesy Los Angeles Chamber of Commerce

LOS ANGELES AS SEEN ACROSS THE MANY VIADUCTS BRIDGING THE LOS ANGELES RIVER

(The tall tower of City Hall rises above the group of buildings forming the Civic Center of Los Angeles.)

tion regarding citizenship and particularly a letter from the executive of their company indicating why they would like to visit a particular plant. In addition to such individual visits as may be arranged with the co-operation of the local committee, it is now expected that it is going to be possible for members to visit a shipyard near Los Angeles and one of the aircraft manufacturing plants. It is advisable therefore that all members be provided with proper identification in the event that these arrangements are completed. Negotiations are in progress for a visit to one of the larger motion-picture studios.

Semi-Annual Business Meeting

The Semi-Annual Business Meeting of members of the Society will be held at the Hotel Biltmore, Los Angeles, on Monday afternoon, June 14, 1943, at 4:00 p.m. This is a correction of the statement which appeared in the May issue.

Program

The following pages contain the program in some detail. However, members are reminded that, because of the war conditions, changes may be made to include more up-to-date subjects pertaining to present conditions. It will be noted that aviation subjects predominate at the Semi-Annual Meeting and no doubt there will be interesting discussions on all phases of America's tremendous strides toward perfection in this vital industry. All phases of problems pertaining to the aviation field, including production, training of women, and technical subjects, will be touched upon and no doubt this meeting will be one of the most outstanding, in so far as our Society is concerned, to further the war effort toward ultimate victory.

President Coes to Address Meeting

President H. V. Coes will address the dinner meeting on Wednesday, June 16. The topic of his speech is "Education for Management," a timely and worth-while subject, one of the high lights of the Semi-Annual Meeting at Los Angeles.

A.S.M.E. 1943 Semi-Annual Meeting Program

Headquarters, Biltmore Hotel

SUNDAY, JUNE 13

9:30 a.m.

Executive Committee of Council

2:00 p.m.

Council Meeting

MONDAY, JUNE 14

9:30 a.m.

Council Meeting

12:30 p.m.

Aviation

Luncheon

Subject: Combat to Cargo Airplanes
Chairman: Dr. W. F. Durand
Speakers: Leaders in aviation

MONDAY (*Continued*)

1 Leader in air commerce
2 Leader in manufacture
3 Leader in government aviation

2:00 p.m.

Aviation (*Continued from luncheon*)

4:00 p.m.

Business Meeting

8:00 p.m.

Aviation—Production Engineering I

(*Panel Discussion on Design for Production*)

Discussers:
Wayne Davies, superintendent of tooling, Douglas Aircraft Co., Inc , Santa Monica, Calif.
J. M. Shumann, director of tooling, Douglas Aircraft Co., Inc., Santa Monica, Calif.
Bert Lloyd, works manager, Vega Aircraft Corporation, Burbank, Calif.
George A. Betts, manager, tool engineering department, Lockheed Aircraft Corporation, Burbank, Calif.
Stanley Carpenter, assistant chief production engineer, Vultee Aircraft Corporation, Downey, Calif.
G. B. Huggins, plant manager, Douglas Aircraft Co., Inc., Long Beach, Calif.
C. W. Perelle, vice-president in charge of manufacturing, Consolidated-Vultee Aircraft Co., Inc., San Diego, Calif.
Problems of Small Manufacturers—Can Subcontracting Work? (Management Division)
Panel Discussion

TUESDAY, JUNE 15

9:30 a.m.

Women in Industry

(*Aviation—Education and Training—Production*)

In co-operation with American Society of Tool Engineers
Women in Industry, by W. G. Tuttle, director, industrial relations, Consolidated-Vultee Aircraft Corporation, San Diego, Calif.
Women in Aircraft Industry, by Wm. A. Simonds, public-relations department, Ford

Official Notice
A.S.M.E. Business Meeting

THE Semi-Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held Monday afternoon, June 14, 1943, at 4:00 p.m. at the Hotel Biltmore, Los Angeles, Calif., as a part of the Semi-Annual Meeting of the Society.

(*Signed*) C. E. DAVIES
Secretary

TUESDAY (*Continued*)

Willow Run Bomber Plant, Ypsilanti, Michigan

Training of Women for Industry, by J. I. Onarheim, employment supervisor, industrial-relations department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

Heat Transfer

The Drying Characteristics of Vegetables, by A. H. Brown and P. W. Kilpatrick, Western Regional Research Laboratory, United States Department of Agriculture, Albany, Calif.

Pressure Drop Accompanying Two-Component, Two-Phase Flow, by L. M. K. Boelter, R. C. Martinelli, E. G. Thomson, and T. H. M. Taylor, University of California, Berkeley, Calif.

12:30 p.m.

Luncheon

The Clock Will Conquer, by Col. James L. Walsh, Chairman, A.S.M.E. War Production Committee, New York, N. Y.

2:00 p.m.

Aviation—Applied Mechanics I

Problems of Elastic Instability in Aircraft Structures, by S. Timoshenko, Stanford University, Calif.

Nonlinear Instability Problems in Aircraft Structures, by Th. von Kármán, California Institute of Technology, Pasadena, Calif.

Aviation—Heat Transfer I

Hot-Wire Anemometer and Its Application to the Measurement of Intake-Manifold Velocities, by F. Ryder, R. C. Martinelli, and A. E. Harrison, University of California, Berkeley, Calif.

The Design and Calibration of a Thermal Anemometer, by R. A. Seban, W. Hillendahl, E. Gallagher, and A. L. London, Stanford University, Calif.

Automatic Temperature-Recording Control Systems, by M. E. Moore, Douglas Aircraft Co., Inc., Santa Monica, Calif.

Management

8:00 p.m.

Aviation—Production Engineering II

In co-operation with American Society of Tool Engineers

Salvaging of Aircraft Structures, by R. L. Schleicher, staff structural engineer, North American Aviation Corporation, Inglewood, Calif.

Small Tools for High Production, by Arthur A. Schwartz, chief tool-research engineer, Bell Aircraft Corporation, Buffalo, N. Y.

Railroad

(*Jointly with Pacific Railway Club*)

Railroad Equipment Needs, Characteristics and Design of the Postwar Era, by L. F. Etter, engineer, charge, service department, Pacific Railway Equipment Co., Los Angeles, Calif.

Materials Adaptable to Railroad Uses That May Be Available in the Postwar Era, by Morris P. Taylor, designer and inspector, Southern Pacific Railway, San Francisco, Calif.

Aviation—Power

Gas Turbines and Turbosuperchargers, by Sanford A. Moss, consulting engineer, supercharger engineering department, General Electric Company, West Lynn, Mass.

TUESDAY (*Continued*)

WEDNESDAY, JUNE 16

9:30 a.m.

Aviation—Hydraulics I

An Introduction to Aircraft Hydraulic Systems, by Howard Field, Jr., hydraulic staff engineer, North American Aviation, Inc., Inglewood, Calif.

Hydraulic Versus Electric Operation of Aircraft Units, by Richard Hayman, Lockheed Aircraft Corporation, Burbank, Calif.

The Evolution of Hydraulic Pumps for Aircraft, Dale Herman, Vickers Inc., Los Angeles, Calif.

Aviation Instruments

Vultee Radio Recorder, by H. D. Griffin, engineer, Vultee Aircraft Corporation, Vultee Field, Downey, Calif.

Electron Microscope, Its Mechanical Features and Its Application to the Field of Metallography, With Special Reference to Aviation Materials, by P. G. Caldwell, district engineering specialist in electronics department of the General Elec. Co., Los Angeles, Calif.

Aviation—Heat Transfer II

Tests and Predicted Behaviors of Engine Oil Coolers, by A. L. London and J. I. Brewster, Stanford University, Calif.

Aircraft Heating Systems: A Critical Comparison of Three Types, by W. W. Reaser, Douglas Aircraft Co., Inc., Santa Monica, Calif.

12:30 p.m.

Luncheon

Application of Air Power, by General E. P. Sorenson, assistant chief of Air Staff Intelligence, War Department, Washington, D. C.

2:00 p.m.

Aviation—Production Engineering—Applied Mechanics

Mechanics of Sheet-Metal Bending, by W. Schroeder, research engineer, Lockheed Aircraft Corporation, Burbank, Calif.

Metal-Forming Technique, G. C. Barber, Douglas Aircraft Co., Inc., Santa Monica, Calif.

Theoretical and Experimental Investigation of Thin-Webbed Plate-Girder Beams, by H. L. Langhaar, structural research engineer, Consolidated Aircraft Corporation, San Diego, California

Aviation—Hydraulics II

The Modern Hydraulic Reservoir: How It Provides Micron Range Filtration and Pump Supercharging, by W. W. Thayer, Douglas Aircraft Co., Inc., Santa Monica, Calif.

Hydraulically Operated Automatic Temperature Control for Aircraft Engines, by S. F. Alleman, General Controls Company, Los Angeles, Calif.

Hydraulic High Pressure, by Jean Mercier, President, Olaer, Mercier Patent Company, New York, N. Y.

Maintenance of Aircraft Hydraulic Systems in Alaska, by Ralph Middleton, chief engineer, Aircraft Accessories Corporation, Burbank, Calif.

WEDNESDAY (*Continued*)

8:00 p.m.

Dinner

Education for Management, by Harold V. Coes, President A.S.M.E.

THURSDAY, JUNE 17

9:30 a.m.

Aviation—Rubber and Plastics I

Physical Properties of a Structural Plastic Material, by Dr. C. W. Armstrong, Lockheed Aircraft Corporation, Burbank, Calif.

Wood-Cloth and Wood-Paper Laminates, by John Delmonte, technical director, Plastics Industries Technical Institute, Los Angeles, Calif.

Petroleum I

Portable Drilling and Well-Servicing Equipment, by James Moon, Franks Manufacturing Corporation, Los Angeles, Calif.

Engine Wear and Its Measurement in the Study of Lubrication, by A. G. Cattaneo and W. Gasser, Shell Development Co., Emeryville, Calif.

Training of Women for Engineering

(*Aviation—Education and Training*)

Engineering Training for Women at Wright Aeronautical Corporation, by C. Wilson Cole, engineering personnel supervisor Wright Aeronautical Corporation, Paterson, N. J.

Training of Women Engineers for the Aviation Industry, by Everett D. Howe, supervisor, E.S.M.W.T., University of California, Los Angeles, Calif.

2:00 p.m.

Aviation—Rubber and Plastics II

Thermoelastic Forming, by W. I. Beach, Plastics Engineer, North American Aviation, Inc , Inglewood, Calif.

Protection of Aircraft Instruments and Delicate Apparatus Against Vibration and Shock by the Use of Rubber, by P. C. Roche, field engineer, Lord Manufacturing Company, Erie, Pa.

Aviation—Management—Engines

Management Problems at Wright Aeronautical Corporation, by R. F. Gagg, assistant general manager, Wright Aeronautical Corporation, Paterson, N. J.

Superchargers for Commercial Airplanes, by R. G. Standerwick, chief engineer, supercharger department, and W. J. King, engineer, General Electric Company, Lynn, Mass.

Petroleum II

Requirements for Relief of Overpressure in Vessels Exposed to Fire, by James J. Duggan, C. H. Gilmour, and E. F. Fisher, process safety division, Carbide and Carbon Chemicals Corporation, So. Charleston, W. Va.

High Pressure Pipe Line Research, by F. W. Laverty and F. M. McNall, Clark Brothers Co., Inc., Los Angeles, Calif.

Butadiene Plant of Southern California Gas Company, by H. L. Masser and J. G. Rollow, Southern California Gas Co., Los Angeles, Calif., and Charles H. Smith, C. F. Braun & Co., Alhambra, Calif.

THE BALTIMORE MUSEUM OF ART

Diesel Engines in Naval Service Theme of 16th National Oil and Gas Power Conference

Baltimore, Md., June 14-16, 1943

THE second wartime National Conference of the Oil and Gas Power Division, A.S.M.E., will focus attention on the use of Diesel engines in naval service, in a program featured by an address by Rear Admiral Earl Mills, assistant chief, Bureau of Ships, an inspection trip to the world-famous U. S. Naval Experiment Station, and a technical session devoted to maintenance of naval Diesel engines. The meeting will be held June 14–16, with headquarters at the Lord Baltimore Hotel, Baltimore, Md.

Other timely technical papers scheduled include: "Present Position and Future Prospects of Diesel Fuels," by A. L. Foster of the *Oil and Gas Journal;* "Recent Developments in the Chrome-Plating of Engine Cylinders," by Russell Pyles, Van der Horst Corporation of America; and "Experience With Chrome-Plated Rings," by Dr. Tracy Jarrett, American Hammered Piston Ring Division, Koppers Company.

Admiral Mills to Speak at Banquet

The session on maintenance of Diesel engines in naval service will feature a paper presented by the Engine Division, Bureau of Ships, to be followed by prepared discussions from representatives of the various engine builders. This session will be held Monday afternoon, June 14. At the banquet that evening, Admiral Mills will be the principal speaker.

The inspection trip to the U. S. Naval Experiment Station will be limited to 150, and proper credentials, including proof of citizenship, must be presented. This trip will highlight the activities of Tuesday, June 15. Another inspection trip of unusual interest will be made on Wednesday evening, June 16, to the plant of the American Hammered Piston Ring Division, Koppers Co. Here the engineers attending will see the manufacture of piston rings from the small precision rings used in aircraft engines to the giant rings used in the low-pressure cylinders of Liberty Ship reciprocating steam engines, the new metallurgical laboratory, and recently completed chrome-plating plant. This trip also will be limited to those presenting proper credentials.

Exhibit to Be Held at Meeting

At the exhibit held in connection with the Conference, more than 20 leading manufacturers of engines and accessories will display the latest in equipment and research developments.

The Women's Program Committee, under the chairmanship of Mrs. A. G. Christie, is planning a series of events for the entertainment of women attending the Conference.

Because Baltimore is a war-boom city and hotel accommodations are in great demand, those planning to attend the Conference are advised to send in reservations promptly and, wherever possible, to arrange for "doubling up" to make the available rooms go as far as possible. Reservation cards will be mailed with the printed program for the meeting, about May 24.

Tentative Program

MONDAY, JUNE 14

10:00 a.m.

Registration

12:00 Noon

Get-Together Luncheon

Welcome by Prof. A. G. Christie, past-president, A.S.M.E., and Honorary Conference Chairman, and by Major E. B. Whitman, president, A.S.C.E., and Honorary Conference Vice-Chairman

2:00 p.m.

Session on Naval Diesel Maintenance

Maintenance of Diesel Engines in Naval Service, presented by Engine Division, Bureau of Ships, Navy Dept. To be followed by prepared discussions from representatives of engine builders

7:00 p.m.

Informal Banquet

Committees

Oil and Gas Power Division Executive Committee

E. S. DENNISON, *chairman*
L. N. ROWLEY, *secretary*
C. W. GOOD, H. E. DEGLER, E. J. KATES, C. E. BECK

Associates

G. C. BOYER — W. K. GREGORY
R. D. CAMPBELL — F. G. HECHLER
M. M. DANA — P. B. JACKSON
G. J. DASHEFSKY — B. V. E. NORDBERG
W. L. H. DOYLE — M. J. REED
LEE SCHNEITTER

Papers Committee

G. C. BOYER, *chairman*
P. B. JACKSON, G. J. DASHEFSKY, R. T. SAWYER

National Conference Committee

General chairman.....W. P. HILL
Honorary chairman.....A. G. CHRISTIE
Vice-chairman.....H. HOLLERITH
Honorary vice-chairman..E. B. WHITMAN
Secretary-treasurer.....L. E CARTER
Registration.....R. J. GREEN
Meetings.....B. W. DERINGER
Exhibits.....E. S. FREEMAN
Inspection trips.....J. A. WORTHINGTON
Entertainment.....S. F. ROBERTSON
Publicity.....J. M MOUSSON
Reception.....R. C. DANNETTEL
Women's Program: MRS. A. G. CHRISTIE, MRS. E. B. WHITMAN, MRS. J. A. WORTHINGTON, MRS. S. F. ROBERTSON

MONDAY (*Continued*)

Rear Admiral Earl Mills, Assistant Chief, Bureau of Ships, Navy Department, speaker

TUESDAY, JUNE 15

9:30 a.m.

Session on Engine Design

Investigation of Large Diesel-Engine Wristpins, by Frank E. Faast, Navy Department

A New Approach to Stress-Strain Calculations for Connecting Rods, by Otto R. Spies, Baldwin Locomotive Works

(*Program continued on following page*)

GEORGE WASHINGTON MONUMENT AT MT. VERNON PLACE, BALTIMORE

TUESDAY (*Continued*)

12:00 Noon

Luncheon and Inspection Trip

U. S. Naval Experiment Station at Annapolis—details as to time of departure and transportation will be announced later

WEDNESDAY, JUNE 16

9:30 a.m.

Session on New Developments

Present Position and Future Prospects of Diesel Fuels, by A. L. Foster, *Oil and Gas Journal*

The Supersonic Reflectoscope for Inspecting Materials, by Prof. F. A. Firestone, University of Michigan

2:00 p.m.

Session on Rings and Liners

Recent Developments in the Chrome-Plating of Engine Cylinders, by Russell Pyles, Van der Horst Corporation of America

Experience With Chrome-Plated Rings, by Dr. Tracy Jarrett, American Hammered Piston Ring Division, Koppers Company

6:00 p.m.

Inspection Trip

Tour through largest piston-ring plant, including new metallurgical laboratory and chrome-plating shop—American Hammered Piston Ring Division, Koppers Company

T. H. Chilton Honored by Columbia Alumni

THOMAS H. CHILTON, member A.S.M.E., director of the technical division of the engineering department of E. I. du Pont de Nemours & Company, Wilmington, Del., has been awarded the 1943 Egleston Medal of the Columbia University Engineering Schools Alumni Association for "distinguished engineering achievement." Mr. Chilton was cited for his outstanding contributions to chemical engineering, science, and technology.

The medal was presented to Mr. Chilton at the seventy-second annual dinner of the engineering alumni on Thursday, April 29, in the Columbia University Club, 4 West 43rd Street, New York City. George E. Sokolsky, author and columnist, was the guest speaker.

The Egleston Medal was founded in 1939 on the seventy-fifth anniversary of the School of Mines in memory of Professor Thomas Egleston, pioneer in engineering education and a member of the Columbia faculty from 1863 until his death in 1900. It is awarded annually to an alumnus who distinguishes himself either in the furtherance of his branch of the profession, in the development of processes or techniques, or in the application of engineering principles.

Previous winners of the award include Irving Langmuir, associate director of the General Electric research laboratory, Schenectady, N. Y.; Reno H. Sales, chief geologist of the Anaconda Copper Mining Company; Grover Loening, inventor of the strut-braced monoplane, and Lazarus White, president of Spencer, White, and Prentis, construction engineers of New York City.

A.S.M.E. Applied Mechanics Division to Hold Tenth National Meeting in Pittsburgh, Pa.

Pittsburgh Section of A.S.M.E. and the Carnegie Institute of Technology to Be Hosts for Division on June 25 and 26

UNDER the auspices of the Pittsburgh Section of the A.S.M.E. and the Carnegie Institute of Technology, the Applied Mechanics Division of The American Society of Mechanical Engineers will hold its tenth national meeting on June 25 and 26.

Registration will start at nine in the morning of the first day in the Exhibition Room of the College of Fine Arts and all meetings will be held in the Little Theater in the same building.

The meeting will be opened by Dr. Webster N. Jones, director of the College of Engineering, Carnegie Institute of Technology, at 9:30 a.m. on June 25, when he will welcome those in attendance. Sessions will be held on plasticity, elasticity, photoelasticity, mechanics of machines, vibration, and thermodynamics.

Dr. Doherty to Speak at Dinner

At the dinner on Friday evening, June 25, Dr. Robert E. Doherty will be the guest speaker. Reservations for the dinner, accompanied by check ($2.50 a person) should be sent as soon as possible (and not later than June 18) to Prof. M. M. Frocht, Carnegie Institute of Technology, Pittsburgh, Pa.

A detailed program follows:

FRIDAY, JUNE 25

9:30 a.m.

Plasticity

The Strength of Cylindrical Dies, by G. Sachs and J. Lubahn, Case School of Applied Science

Nonlinear Longitudinal Stress Waves in Nonuniform Bars, by Le Van Griffis, Illinois Institute of Technology

Stress-Strain Relations Under Combined Stress, by E. A. Davis, Westinghouse Electric & Manufacturing Company

Failure From Creep as Influenced by the State of Stress, by W. Siegfried, Sulzer Brothers, Winterthur, Switzerland

2:00 p.m.

Elasticity and Photoelasticity

Chairman: M. Hetényi, Westinghouse Electric & Manufacturing Company

Stress in Aeolotropic Cylinders, by G. H. Carrier, Cornell University

Studies in Three-dimensional Photoelasticity, by M. M. Frocht, Carnegie Institute of Technology

Photoelastic Separation of Principal Stresses by Oblique Incidence, by D. C. Drucker, Cornell University

Dinner

7:00 p.m.

Hotel Webster Hall

FRIDAY (*Continued*)

Some informal remarks by Dr. Robert E. Doherty, president of the Carnegie Institute of Technology

SATURDAY, JUNE 26

9:30 a.m.

Mechanics of Machines, Vibration, Thermodynamics

Chairman: L. M. Tichvinsky, U. S. Naval Experiment Station, Annapolis

Static and Dynamic Spring Constants, by G. Horway and J. Ormondroyd, David Taylor Model Basin, Washington, D. C.

On Cutting Gears and Worms, by D. W. Dudley and H. Poritsky, General Electric Company

Temperature Relations in Journal-Bearing Systems, by M. Muskat and F. Morgan, Gulf Research & Development Company

A Table of Thermodynamic Properties of Air, by J. H. Keenan and J. Kaye, Massachusetts Institute of Technology

Accommodations

Of the many hotels in Pittsburgh, the following are within easy walking distance of the campus of the Carnegie Institute of Technology:

Schenley Hotel:	Single, $3.85 to $4.50 Double, $6.00 to $6.50
With tub and shower	Single, $4.50 to $5.50 Double, $7.00 to $8.00
Hotel Webster Hall:	Single, running water, $2.25; shower, $3.00 up Double (twin), running water, $3.50 Double (twin), tub, shower, $6.00, $7.00

Reservations should be made directly with the hotels, well in advance.

Local Committee

Chairman: M. M. Frocht, Carnegie Institute of Technology

T. G. Estep, Carnegie Institute of Technology R. E. Peterson, Westinghouse Electric & Manufacturing Company

Pittsburgh Section, A.S.M.E.

Chairman: T. J. Barry of firm of T. J. Barry, Park Bldg., Pittsburgh, Pa.

Secretary: K. F. Treschow, William Penn Hotel, Pittsburgh, Pa.

President's Page

Why Engineers Should Take an Interest in Management

ENGINEERS cannot avoid relations with management, nor can they afford not to obtain a good working knowledge of the basic principles of modern management, of sound organization, and of equitable labor relations *if* they expect to get ahead in their profession.

Too many engineers do not know enough about management. One may be an expert in his own field and still make mistakes if he assumes that he is an expert in another field with which he is not thoroughly familiar, such as management. An engineer may be an able organizer, administrator, and manager, but one hears too often this comment:

"Yes, he is an able engineer but he is a lone wolf. It is difficult to get him to co-operate. He takes the position that because he knows more about the subject in which he is an expert than we do, he is right. He has given his opinion and that is that."

Now it is not enough for an engineer to be right, he must be persuasive as well and able to sell his ideas to others. He must not be "high-brow" and dogmatic.

My experience has taught me that two thirds of the problems that come before me in my professional capacity stem from violations of organization principles.

Consider the problem, for the moment, in the field of personnel management. One authority has distinctly stated it as follows:

"The truth might as well be faced, the standards for the personnel profession are loose and ill defined and this goes for many managerial jobs. This is principally the fault of personnel executives themselves and partly that of top management. The former have made no real sustained and co-operative effort to develop any professional standards, while the latter have all too frequently been careless in selecting men for the important job of handling the industry's human relations."

Don't you think engineers may have some responsibility in helping to remedy this situation? They know how to establish standards; perhaps that technique can be used to assist here.

The engineer should take an interest in industrial relations and should contribute sound thinking on the subject. He should become familiar with the problems of the day's work from labor's point of view. There is more to this than just applying the techniques of time and motion study and job analysis, subjects in which many engineers have been greatly immersed and have made some real contributions in the field. There are human values—human aspirations—which must be considered, and it is with these that the engineer must be concerned.

There is the evolving of an art in guiding management by means of statistical control, the determination of what the range or belt of probabilities is, and how this technique can be applied to assist management in effective regulation and control.

One authority has stated: "Our management battle is a hard one. Opposition (our enemies) is grim and desperate. A new and quicker production idea, a faster employee-training method, a few months of life gotten out of an old machine, a department's bettering of last month's record, a subcontractor educated to better management policies; this is the stuff of which management victories are made."

Don't you think that engineers have a responsible relation to management with respect to many of the foregoing items in furtherance of the war effort?

After the war the engineer could well direct some of his talents to the problems of mass distribution. We have successfully solved many of the problems of mass production but our technique of mass distribution is way behind our technique of mass production.

After all, management is directing, guiding, and co-ordinating people. You can talk to a full-automatic lathe until you are blue in the face and nothing will happen except a rise in your blood pressure. But you can direct a skilled workman to operate the machine along predetermined lines and the results required will be forthcoming.

Management has been defined as "getting things done through the efforts of other people." This involves two major responsibilities:

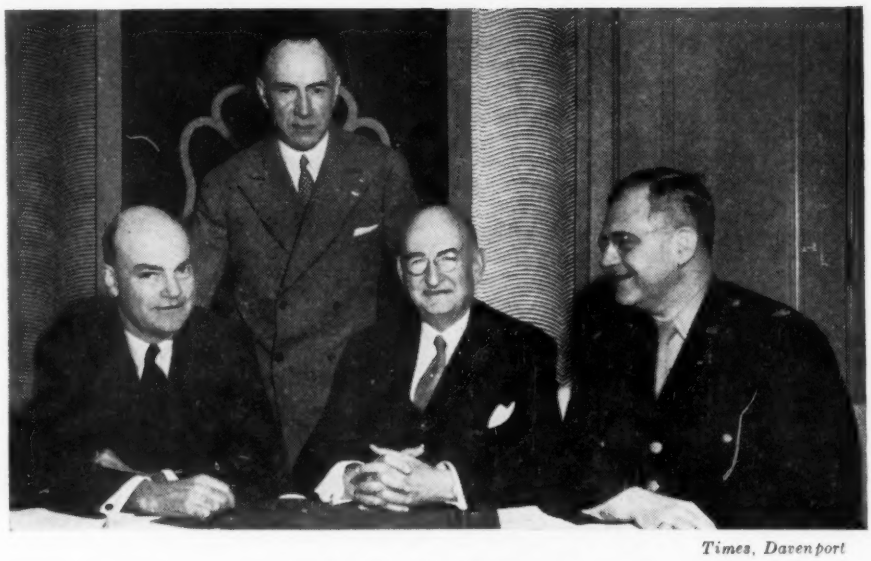
(1) Planning—what we want people to do and how to do it.

(2) Operation control—control of the various functions so as to require people to work according to the plan and the prescribed methods and know that they are doing it.

This means sound organization structure and good supervision.

I like to think of management as the catalytic agent between ownership, consumers, employees, industry, and society (government), on the one hand, and the various functions of the business such as production, sales, finance, accounting, and the like, on the other. A true catalyst is not transformed. Neither should management be transformed. It must not be transformed by labor, by ownership, or by government to reflect, to the exclusion of the others, only one of these factors. If it does, then the results of management will be just as faulty as the results of chemistry where the catalyzer fails. This fact is all too often forgotten.

(*Signed*) H. V. COES, *President, A.S.M.E.*



Times, Davenport

AT THE DAVENPORT MEETING

Left to right: James W. Parker, past-president, William A. Hanley, past-president, Harold V. Coes, president, and Col. C. E. Davies, secretary, The American Society of Mechanical Engineers.)

War Themes Dominate Program at A.S.M.E. Spring Meeting, Davenport, April 26–28

Recent Developments—War Manpower and Aviation Speakers Attract Attention

IN THE opinion of a majority of the 500 members and guests in attendance at the Spring Meeting of The American Society of Mechanical Engineers, held at the Hotel Blackhawk, Davenport, Ia., April 26–28, the high point of dramatic interest was the luncheon address of Lieutenant Colonel Nathaniel F. Silsbee on Tuesday noon, "Problems of Global Air War." The published text of Colonel Silsbee's address appeared as the leading article in MECHANICAL ENGINEERING for May, but the reader will miss the enthusiastic personality of the author and the many interesting side lights with which he amplified his talk. So insistent was the audience at Davenport that Colonel Silsbee was prevailed upon to continue for approximately an hour after the luncheon, which had to be adjourned in time to permit the convening in other parts of the hotel of four other technical sessions.

General Ramsey Outlines Mechanical Engineers' Jobs

Although no formal banquet was scheduled, two dinners, one on Monday and the other on Tuesday evening, with three luncheons, one each on Monday, Tuesday, and Wednesday, afforded opportunity for the entire group of members and guests to assemble as one body.

The opening luncheon on Monday noon was under the direction of Thomas L. Wilkinson, fellow and past vice-president A.S.M.E., consulting engineer, Davenport, Ia., who delivered a brief address of welcome. H. V. Coes, president A.S.M.E., responded. Brigadier General N. F. Ramsey, U.S.A., commanding, Rock Island Arsenal, honorary chairman of the 1943 A.S.M.E. Spring Meeting, spoke on "The Mechanical Engineer at the Rock Island Arsenal." General Ramsey, after a short review of the history of Rock Island Arsenal, commented briefly on the many duties performed by mechanical engineers working under his direction. In addition to functions performed in design details, materials selection, co-ordination of design with manufacturing, specifications, gaging, tooling, methods planning, layout, routing, testing, and studying causes of failure of products, mechanical engineers, he said, were concerned with buildings and equipment, shop services, power improvements, substitution of materials, railroads, bridges, locks, and dams. He was, he announced in closing, hopeful of being able to assist in making the meeting a success.

J. C. Hobbs Makes Plea for Plant Maintenance

At the dinner on Monday evening James W. Parker, past-president A.S.M.E., and vice-president and general manager, The Detroit Edison Company, Detroit, Mich., presided. Speaking on "Plant Perpetuation," J. C. Hobbs, fellow A.S.M.E., engineering consultant, U. S. Navy, Washington, D. C., and vice-president, Diamond Alkali Company, Painesville, Ohio, paid tribute to the Prime Movers Committee of the Edison Electric Institute for what it had done to improve operating conditions and maintenance in central power stations by frank discussion of problems, difficulties, and failures experienced in day-by-day operation. Mr. Hobbs laid great stress on the desirability of eliminating in so far as possible every piece of equipment that was nonessential and the necessity for continuous and intelligent maintenance.

Coes and Walsh Speak at Dinner

Colonel C. E. Davies, secretary A.S.M.E., presided at the dinner on Tuesday evening. He spoke briefly of the significance of management in engineering and of the rich literature in this field that was contained in the publications of The American Society of Mechanical Engineers. Among the many persons identified and introduced to the audience by Colonel Davies were Thomas L. Wilkinson and Kenneth R. Hodges, general chairmen of the meeting, whom he warmly praised for their services to the Society. Two addresses, published in this issue were delivered by H. V. Coes, president A.S.M.E., and James L. Walsh, chairman A.S.M.E. War Production Committee. The title of Mr. Coes' paper was "What Management Is Contributing to the War Effort." Colonel Walsh's subject was "Engineers Against Time."

After the addresses, Dr. John E. Younger, secretary, A.S.M.E. Aviation Division and 1941 Spirit of St. Louis Medalist, described briefly the Sikorsky Helicopter, with the aid of a reel of motion pictures of this novel and promising craft kindly provided by the inventor, Igor Sikorsky.

Management of Loading Plants Discussed by General Shinkle

At the luncheon on Wednesday, General E. M. Shinkle, general manager, Day and Zimmerman, Inc., Iowa Ordnance Division, Burlington, Ia., read a paper entitled "Manning and Management of a Loading Plant," in which he discussed the management problems involved in the manufacture of explosives.

Many Divisions Sponsor Technical Sessions

It was only a few years ago that an A.S.M.E. Annual Meeting program was as rich in technical papers as was the one offered at Davenport this year. Without counting luncheon and dinner addresses, or the individual contributions to symposia, 49 technical papers were presented at the 1943 Spring Meeting. With few exceptions, every paper was either directly concerned with the problems growing out of the war or with production, design, and operating techniques that are being used on the home battle front Comments by members and guests attested to the value of the papers and discussions and demonstrated why engineers, among the busiest persons in the nation today, found it worth while to interrupt their daily schedules to attend the meeting.

The wholehearted co-operation of General N. F. Ramsey, commanding, Rock Island Arsenal, who acted as honorary chairman of the meeting, was responsible for a large attendance and valuable contributions from the officers and civilian personnel of the Arsenal. At General Ramsey's request the Society arranged a number of informal conferences on specific topics on which information was desired. Attendance at these conferences was restricted in order that discussion of the topics could be frank and detailed without fear of secret information getting into improper hands. The panels were made up of approximately equal numbers of Arsenal representatives and experts

in the fields under discussion whose names had been provided by the A.S.M.E.

Wood Industries Division Co-Operates

Developments in the field of the Wood Industries Division, which have been rapid and astounding as a result of war pressure, were reported in a series of papers sponsored by the division and presented at three sessions held at Davenport. These sessions were in effect a national meeting of the division and they attracted a large group and much favorable comment.

In addition to its technical sessions, the division scheduled a visit to the plant of William White and Company, Moline, Ill., manufacturers of presses, hot plates, rolls, shears, and other machinery.

The nine technical papers presented at the three Wood Industries sessions were largely devoted to various phases of the plywood industry and to uses to which plywood is being put in the war program.

Delamination tests of plywood and a proposed specification were reported by C. W. Muhlenbruch, of Carnegie Institute, Pittsburgh, Pa.

Ralph Casselman, of the Bakelite Corporation, Bloomfield, N. J., in a paper on resin-impregnated wood, described the use of synthetic resins in making impreg and compreg and described applications of resin-impregnated woods.

A review of progress since 1930 in the technique of gluing plywood to form curved surfaces was presented by Thomas D. Perry, of Resinous Products and Chemical Company, Inc., Philadelphia, Pa., in a paper entitled, "Flexible Pressure in Veneer and Plywood Work," which appears in this issue.

Observations on the density and shrinkage of ponderosa pine wood were reported by Robert A. Cockrell, of the University of California, Berkeley, Calif., on leave of absence with the Forest Products Laboratory, Madison, Wis.

Harry F. Lewis, of the Institute of Paper Chemistry, Appleton, Wis., described researches on plastic developments from redwood and displayed some articles made from the plastics.

The field related most closely to the war uses of wood was covered in a number of papers. Robert C. Perkins, Central States Aircraft Veneer Committee, Chicago, Ill., spoke on war applications of hardwood and veneer, and Paul H. Bilhuber, in collaboration with Walter Godfrey, described the results of development work on the use of high-frequency gluing of aircraft parts at Steinway and Sons, New York, N. Y.

Times, Davenport

LIEUT. COL. N. F. SILSBEE

Three papers were presented at a session co-sponsored by the Aviation and Wood Industries Divisions. Robert W. Hess, Curtiss-Wright Corporation, Buffalo, N. Y., discussed plywood use in aircraft, and Jay M. Stevens, Fairchild Engine and Airplane Corporation, Hagerstown, Md., reviewed problems of construction and alternate substitution in plywood for use in aircraft manufacturing. Finishes for plywood in the aircraft industry were described by Roy B. Anderson, of the industrial research division, Wipe-On Corporation, New York, N. Y.

Desiccation of Blood Plasma

At the opening session of the meeting David C. Pfeiffer, of the Dallas Power and Light Company, Dallas, Texas, presented an engineering discussion of the desiccation of human-blood plasma in which he described how the principles of vacuum drying from the frozen state have been applied to five acceptable methods of human-blood dessication now in use. Types of drying units at Baylor University Hospital, in the design of which Mr. Pfeiffer assisted, were also described.

Times, Davenport

COL. JAMES L. WALSH

War Manpower and Management

At a session on industrial training and the war effort under the auspices of the Committee on Education and Training for the Industries, two representatives of industry and one of the War Manpower Commission provided material for lively discussion. R. O. Johnson, supervisor of training, International Harvester Company, Chicago, Ill., described his company's wartime training program. James D. Shevlin, training director, Deere and Company, Moline, Ill., speaking on induction and orientation, presented excellent material he has prepared on this subject which is available in published form from the National Foreman's Institute.

Times, Davenport

DR. JOHN E. YOUNGER AND NEVIN E. FUNK

The services of T.W.I. (Training Within Industry) were described by A. E. Peterson, of the T.W.I. Headquarters Staff, War Manpower Commission, Chicago, Ill.

At a session on Monday evening also sponsored by the Committee on Education and Training for the Industries the government's training services were further discussed. L. S. Hawkins, director of vocational training for war-production workers, U. S. Office of Education, Washington, D. C.; C. W. Beese, director, E.S.M.W.T., Purdue University, Lafayette, Ind.; and Philip S. Van Wyck, Bureau of Training, War Manpower Commission, Washington, D. C., were the authors of the papers presented.

Fitting closely into the sessions on training held on Monday was the Management Division's Tuesday session on "Women—The Answer to the Manpower Shortage," at which the speakers were B. I. Beverly, director of health and personnel, Republic Drill and Tool Company, Chicago, Ill., whose subject was personnel methods used in the employment of women industrial workers; and William F. Sherman, director of foreman training, Rock Island Arsenal, Rock Island, Ill., who predicted that by next January there will be nearly six million women workers in war production in this country.

The Aviation Division's contribution to the discussion of the training problem took the form of a session on Tuesday morning devoted to the program of the Civil Aviation Authority. John P. Norris, director of the war-training program in colleges, C.A.A., Washington, D. C., told about the revised policy of C.A.A. in war training, and Elmer C. Lundquist, University of Iowa, Iowa City, Ia., spoke of the C.A.A. program from the teacher's standpoint.

One of the engineering aids to war-industry training, that was described in a dramatic fashion at two sessions arranged for the Management Division by Ralph M. Barnes, professor of industrial engineering, University of Iowa, Iowa City, Ia., is motion study. At an introductory session on Monday afternoon sound motion pictures of motion-study applications were presented. These training plans were produced at the industrial-engineering laboratory, University of Iowa.

At the evening session which followed, Dr. Arthur Steindler, head of orthopedic surgery, College of Medicine, University of Iowa, Iowa

City, Ia., presented a paper on human locomotion and the engineering sciences, in which he drew a convincing picture of the aid which biomechanics can be to engineering studies of motion economy and fatigue.

How motion study had been applied to workers in the canning and packing industry was described by William J. Biehl, supervisor of methods development, Libby, McNeill, and Libby, Chicago, Ill. This informal talk was illustrated with one of the colored films used in training olive packers.

Carrying motion study to the farm and the program of farm-work simplification were explained by Marvin E. Mundel, co-director, Farm Work Simplification Laboratory, Purdue University, Lafayette, Ind.

At a session on manpower utilization under the auspices of the Management Division, W. H. Kushnick, director of civilian personnel and training, War Department, Washington D. C., presented a management check list for manpower utilization. The paper will be found in this issue, pp. 410–411.

George J. Huebner, chief of tooling section, Smaller War Plants Corporation, Washington, D. C., described the work of that agency in assisting small business to fit into the war-production picture.

Production-Engineering Division

The varied program of the Production Engineering Division included papers on powder metallurgy, machining of airplane-engine parts, broaching of rifle barrels, steel forging, glass gages, and safety in ordnance plants.

Speakers at the symposium on powder metallurgy applied to ordnance equipment and matériel included Fred Rhines, Carnegie Institute of Technology, Pittsburgh, Pa.; T. L. Robinson, Amplex Division, Chrysler Corporation, Detroit, Mich.; and F. V. Lenel, Moraine Products Division, General Motors Corporation, Dayton, Ohio. A contribution by Charles Hardy, president, Charles Hardy, Inc., New York, N. Y., was read by W. J. Hargest, of the *American Machinist*, McGraw-Hill Publishing Company, New York, N. Y., who arranged for the program.

H. E. Linsley, Wright Aeronautical Corporation, Paterson, N. J., showed illustrations which contrasted former and present production methods in aircraft-engine manufacture and motion-picture films of modern operations. His paper will be published shortly.

Development of broach rifling at Rock Island Arsenal was described by William Baumbeck, chief superintendent of production, Rock Island Arsenal. The paper is in this issue.

For the A.S.M.E. Special Research Committee on the Forging of Steel Shells, W. Trinks, project director of the committee, made a brief report of its activities and spoke on the forging of high-explosive shells on bulldozers.

Bringing up to date developments in the field of glass gages, reported in the April issue of MECHANICAL ENGINEERING, Colonel H. R. Hambleton, chief of gage section, U. S. Ordnance Department, displayed various types of glass gages which are being introduced to save steel. Representatives of the Corning Glass Works and the T. C. Wheaton Company, two of the glass manufacturers who have cooperated in the developments, supplemented Colonel Hambleton's comments.

The organization and functions of the Safety and Security Branch, U. S. Ordnance Department, were outlined by Colonel Crosby Field, assistant director of safety, U. S. Ordnance Department. Colonel Field's paper was published in the May issue, pp. 353-359.

Power and Fuels Papers

In the fields of power and fuels there were six sessions at Davenport sponsored by the Power and Fuels Divisions. One of these was a panel discussion on the storage of coal, held on Wednesday morning.

At a session, held on Monday morning and devoted to the operation of industrial power plants during wartime, G. H. Suhs, of the Sorg Paper Company, Middletown, Ohio, used as an example conditions in the paper industry. At the same session Otto de Lorenzi, Combustion Engineering Company, Inc., New York, N. Y., showed colored motion pictures of actual furnace operating conditions existing on various types of stokers and spoke briefly of details of stoker operation.

On Monday evening, W. L. Webb and R. G. Call, American Gas and Electric Corporation, New York, N. Y., described a caustic-soda-solution washing procedure used by their company for removing turbine deposits. A paper dealing with a technique of using inhibited hydrochloric-acid-base solvents to remove scale from heat-exchanger equipment was presented by F. N. Alquist and C. H. Groom, Dow Chemical Company, Midland, Mich., and Guy F. Williams, Dowell, Inc., Tulsa, Okla.

Two papers on tube expanding were presented under the joint auspices of the Power Division and the Research Committee. A. Nadai, Research Laboratories, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., explained the theory of the expanding of boiler and condenser tube joints through rolling; and P. G. McVetty, also of the Westinghouse Research Laboratories, recommended the use of the hyperbolic sine to express the relation between stress and creep rate at constant temperature.

Iowa coals were discussed by H. L. Olin, University of Iowa, Iowa City, Ia., in a paper which appeared in the May issue, pp. 343–346; and the influence of storage conditions on the size degradation, size stability, and friability of lignite was explained by Carl J. Eckhardt, University of Texas, Austin, Texas, in a paper prepared jointly by him and Chapin W. Yates, also of the University of Texas.

Julian R. Fellows, University of Illinois, Urbana, Ill., described the performance of a downdraft coking furnace for domestic use. This paper was published in the May issue.

A paper on overfire-air jets was presented by Richard B. Engdahl and W. C. Holton, Battelle Memorial Institute, Columbus, Ohio, and, at the same session, R. M. Rush and B. B. Reilly, of the Dravo Corporation, Pittsburgh, Pa., described direct-fired air heaters for dehydration and chemical processes.

Heat Transfer

Four papers were discussed at two sessions under the auspices of the Heat Transfer Division. Elmer S. Davis, Alco Products Division, American Locomotive Company, New York, N. Y., gave some new equations for heat transfer and pressure drop for turbulent and laminar flow. "Heat Transfer to a Fluid Flowing Periodically at Low Frequencies in a Vertical Tube" was the title of a paper prepared by R. C. Martinelli and L. M. K. Boelter, University of California, Berkeley, Calif., E. B. Weinberg, Modesto Junior College, Modesto, Calif., and S. Yakahi, former graduate student, University of California.

A general approximate method of solving freezing-ice problems and applications to ice formation at spherical, cylindrical, and plane boundaries was presented by A. L. London and R. A. Seban, Stanford University, Stanford University, Calif.

Joseph Lichtenstein, Foster Wheeler Corporation, New York, N. Y., presented a paper on performance and selection of mechanical-draft cooling towers.

Committees

Responsible for the 1943 Spring Meeting at Davenport was the Committee on Meetings and Program, of the Society, of which Nevin E. Funk was chairman. The Davenport committee which made the local arrangements was under the general chairmanship of Kenneth R. Hodges, with General N. F. Ramsey as honorary chairman. The honorary chairmen from neighboring A.S.M.E. local sections were: L. J. Fletcher, Central Illinois; J. R. Michel, Chicago; M. A. Durland, Kansas City; R. J. Smith, Milwaukee; L. C. Sprague, Minnesota; J. K. Ludwickson, Nebraska; B. G. Elliott, Rock River Valley; and R. C. Thumser, St. Louis.

Subcommittees serving at Davenport were: reception, Thomas L. Wilkinson, chairman, and Paul E. Todd; hotel, Charles A. Carlson, chairman; technical events, Erick Erickson, chairman, Francis C. Huyser, Bruno C. Lechler, Harry P. Wilson, and John S. Wylie; plant trips, Robert A. Cross, chairman, Eric Rahlson, and Ray Rath; publicity, Paul E. Anderson, chairman.

Lamme Medal Awarded to T. E. French

SELECTION of Dr. Thomas E. French, Member A.S.M.E., as recipient of the 1943 Lamme medal award for meritorious achievement in engineering has been announced by President Howard L. Bevis of The Ohio State University.

This medal, awarded each year to an Ohio State alumnus who has distinguished himself in engineering, is named for its donor, the late Benjamin G. Lamme, who was a noted engineering graduate in his own right. Dr. French will receive the award June 11.

A.S.M.E. Members Honored by The Franklin Institute

AT the annual medal-day ceremonies of The Franklin Institute, Charles M. Allen, Fellow A.S.M.E., former manager and vice-president A.S.M.E., 1936 Worcester Reed Warner Medalist, and professor of hydraulic engineering Worcester Polytechnic Institute, was awarded the Elliott Cresson medal "for his inspired contribution to the field of hydraulics."

On the same occasion Harry M. Pflager, member A.S.M.E., senior vice-president of the General Steel Castings Corporation, was awarded the George R. Henderson medal for his methods of designing and casting locomotive beds in one piece.

Among the Local Sections

Metropolitan Section Closes Successful Season With Meeting at the Hotel Pennsylvania, April 30

Six Hundred in Attendance

THE Metropolitan Section of the A.S.M.E. has just finished its season of meetings in which an unusual number of papers important and essential to the war program have been presented before its members.

In keeping with its custom of long standing the Section members relax a bit at a late-season meeting known as the Spring Round-Up. The meeting this year was a smoker held on April 30 at the Hotel Pennsylvania with 600 in attendance. It was voted a successful ending to a busy winter schedule of technical papers. A social meeting such as this does much in these trying times to relieve the tension of days filled with wartime engineering problems.

The various subcommittees responsible for the success of the smoker were headed by W. L. Betts with H. A. Johnson handling the promotion; C. A. Hescheles, publicity; H. R. Kessker, seating; J. H. Kroose, dinner; and G. G. Hyde, entertainment.

Atlanta War-Production Clinic

THE Atlanta Section reports a successful War Production Clinic with an attendance of more than 350. Sir Gerald Campbell, the speaker of the evening, gave an inspiring talk on his personal experience here in America during the war. Robert M. Gates, president of the Air Preheater Corporation, past vice-president A.S.M.E., spoke on the problems confronting the Atlanta District—of training men in their local war industry. The Bell Aircraft Corporation needed 40,000 men during the week of April 12 and most of these men need training. He stressed the fact that we must become adaptable to this change from peace to war work.

Buffalo Hears About the Army on Wheels

The Buffalo Section met on April 29 with an attendance of 150. They heard C. E. Harrington of Paragon Research, Inc., Mem. A.S.M.E., discuss "The Army on Wheels." Motion pictures were used by Mr. Harrington showing the remarkable performance of the amphibian car on both land and water. Many of the important problems encountered in its design were discussed.

Central Indiana Section Sees Film on Die Casting

The Central Indiana Section on April 23 enjoyed a film on "Die Casting" made by the New Jersey Zinc Company. This film clearly portrayed the fundamentals of die casting, the method of operation, and the time and material savings effected. The audience was particularly impressed with the fact that extremely complicated parts could easily be produced by this method and that very close tolerances could be held.

Prof. J. E. Younger Heard at Central Pa. Section

The Central Pennsylvania Section heard Prof. J. E. Younger at a joint meeting with the Centre County Engineers Society on April 8. Professor Younger spoke on "Fundamentals of High-Altitude Flying With Pressure Cabins."

Bogart Discusses "An Invisible Saboteur" at Chicago

The Chicago A.S.M.E. Section met on March 22 to hear Mr. Vande Bogart whose subject was "Corrosion—An Invisible Saboteur." He discussed up-to-date corrosion problems so important at present when the available supply of metals and alloys must be stretched to meet today's needs. Protective coating and corrosion prevention were considered in the light of new research. Slides were used to illustrate the talk. J. E. Davis, test engineer, Air Corps, engineering division, Ford Motor Co., Dearborn, Michigan, Mem. A.S.M.E., gave a talk on "Production Testing of Aircraft Engines," covering a description of test equipment, tests made, and observations on testing technique as carried on in some of the large engine factories.

Professional Ethics at Cleveland

On April 8 the Cleveland A.S.M.E. Section heard James H. Herron, president of James H. Herron Co., Cleveland, Ohio, and past-president A.S.M.E., speak on "Professional Ethics." This was a social meeting with the Case Student Branch.

Synthetic Rubber Talk at Colorado Section

The Colorado A.S.M.E. Section at its meeting on March 25 was addressed by H. G. Naylor, chief engineer of the Gates Rubber Company, on "Synthetic Rubber." This was Student Branch night also and the student speaker, Charles H. Hill, spoke on "The Engineer as a Citizen."

Geopolitics Explained at Columbus Section

On April 26 the Columbus Section attended the annual ladies' night meeting with a dinner at the Faculty Club of the Ohio State University. A talk was given by Dr. Guy Harold Smith, chairman of the department of geography, on "Geopolitics." Dr. Smith described what was meant by "geopolitics" and named some of the individuals who seem to be the originators of the ideas it embodies. He explained how a nation, by gaining control of a comparatively small key area could then control a much larger area; and by controlling this larger area a continent could be dominated and finally the whole world could be controlled.

Oil and Aircraft Problems At Detroit

The Detroit Section of the A.S.M.E. met on April 9 when T. A. Boyd, head of the General Motors research laboratories fuel division, spoke on the subject of "Oil and Turmoil." Mr. Boyd showed by maps, charts, and slides the location of the world's oil supply, pointing out the fortunate position of the United States. A film on "The End of the Beginning" illustrated the manufacture involved in converting a large plant from automobile assembly to aircraft production.

East Tennessee Section Hears A. R. Mumford on Combustion

On April 9 the East Tennessee A.S.M.E. Section enjoyed hearing A. R. Mumford, development engineer of the Combustion Engineering Company, New York, N. Y., Fellow, A.S.M.E., who spoke on "Combustion Problems and Fuel-Burning Conditions." The speaker was formerly associate director of research for the New York Consolidated Edison Company and spoke from firsthand knowledge of the subject.

Kansas City Section Attends Student Convention

The Kansas City Section met on April 23 with the students attending the A.S.M.E. Student Convention at their banquet. Mr. Robert Whitmer of the Transcontinental and Western Airlines, Inc. gave an interesting talk on flight control, discussing the many problems and methods involved in the control of commercial aviation.

Mid-Continent Section A.S.M.E. Awards

The spring meeting of the Mid-Continent Section of the A.S.M.E. was held on April 23 for the presentation of student papers. This year's award went to S. F. Bird of the Univer-

sity of Oklahoma whose subject was "Soil Analysis" particularly as applied to the location of oil and gas deposits. Second place went to Morris Weingarten of Oklahoma A.&M. College who presented a paper on "The Ignition Lag in Compression Engines."

New Haven Section Listens to Major Skinner

The New Haven Section met on April 20 and heard Major James Skinner talk on "Army Air Force Technical Training School." He explained how the cadets at Yale are chosen, the courses of instruction, and the sort of work they will do out in the field.

Norwich Section Hears de Zafra on Shipbuilding

The Norwich Section had a meeting on April 27 at which Prof. Carlos de Zafra spoke on "Production Engineering Applied to Shipbuilding." Professor de Zafra discussed basic shipbuilding organization, properly correlating such factors as labor, materials, production control, central-control-office function, and the use of graphic charts for gathering information.

Col. H. B. Hambleton Speaks at Providence

On April 6 the Providence Section heard Col. H. B. Hambleton, who is in charge of the gage section of the Ordnance Department in Washington, D. C., discuss "Glass Gages." This was based upon his article in the April issue of MECHANICAL ENGINEERING, pp. 274 to 276. Representatives of glass companies were present and four Ordnance Officers from Frankford Arsenal also attended to explain technical problems of glass manufacture and handling.

Steam Turbines for Marine Use at San Francisco Section

On April 1 the San Francisco Section had an interesting meeting, at which Harold Ewing, design engineer of the Joshua Hendy Iron Works in Sunnyvale, Calif., presented a paper on "Building of Steam Turbines on the West Coast for Marine Use." He illustrated his talk with slides and design details of various methods used in building steam turbines as well as installation and operation problems. In 1941 the Joshua Hendy Iron Works negotiated a license agreement with the Westinghouse Electric and Manufacturing Company for the purpose of building main propulsion equipment of Westinghouse design at Sunnyvale.

St. Joseph Valley Section Enjoys Talk on Stainless Steel

At a meeting on April 16 the A.S.M.E. Section of St. Joseph Valley heard George Hinkle, metallurgist of the Republic Steel Corporation, Massillon, Ohio, discuss "Enduro Stainless Steel." This talk was accompanied by a sound film showing the manufacture of stainless steel from the mining of ore in far-off Rhodesia to the mirror-finished sheet. Every phase of production and fabrication of stainless steel was shown. Otto Zahn from Mishawaka, Ind., was program chairman.

Seal Hunting Is Subject at Ladies' Dinner Party

The St. Louis Section of A.S.M.E. held a dinner meeting for the ladies on April 27 when a film on "The Quest of the Alaskan Seal Skin" was presented by B. L. Lange, Fouke Fur Company, St. Louis, Mo. This picture showed seal hunting in the Pribil of Islands.

Tri-Cities Sections Reports Further on War Production Conference

On March 4 the Tri-Cities Section held its War Production Conference for the solution of manufacturing problems sponsored by technical societies and trade groups. E. H. Sohner, superintendent of the Quad-Cities Tank arsenal for International Harvester Company, was honorary chairman. James R. Allen, assistant manager of the industrial and construction department of the International Harvester Company, addressed the manufacturers and technicians on, "Occupational Disease Control." The panel topics, and the sponsors were as follows: (1) "Panel on Tool Design," American Society of Tool Engineers; (2) "Panel on Welding," The American Society of Mechanical Engineers; (3) "Panel on Plant Maintenance," American Society of Civil Engineers; (4) "Panel on Metallurgical Problems," American Society for Metals; (5) "Panel on Electrical and Power-Plant Maintenance," American Institute of Electrical Engineers and National Association of Power Engineers.

Waterbury Section Hears Dr. H. B. Osborn, Jr.

The Waterbury Local Section met on April 20. They listened to H. B. Osborn, Jr., discuss "Surface Hardening by Induction." Dr. Osborn told of recent outstanding developments in this field, such as heat-treating by application of high-frequency induction, and heating to localize surface hardening. This process causes no distortion or scale formation and requires no expensive pretreatment such as copper plating and carburizing.

Progress of the Telephone at Western Massachusetts

The A.S.M.E. Section of Western Massachusetts held its regular monthly meeting at Springfield, Massachusetts, on April 20. Fifty members and guests were present, including invited guests of the Springfield Section of the American Institute of Electrical Engineers. Carl Hiland, in charge of arrangements for the evening, introduced Thomas Cooper, Jr., transmission engineer of the New England Telephone and Telegraph Company. Mr. Cooper traced the telephone industry and equipment from its outset up to the present day, relating developments which have taken place in subscriber telephones, office equipment, and channels of communication. Lantern slides were of help in explaining the telephone's advancement through research and planning. A film was shown on "Coaxial" which illustrated the manufacture, installation, and use of coaxial cable over which hundreds of messages can be sent at one time.

High-Speed Steels Discussed at West Virginia

The West Virginia Section at its meeting on March 23 heard Ray P. Kells and Leonard C. Grimshaw speak on "The Characteristics, Handling, and Use of Tool Steels and High-Speed Steels." His talk was illustrated with slides showing the chemical proportions of the alloying elements and the resulting physical properties. Mr. Kells then led an extensive discussion on these steels and answered many questions from the floor.

With the Student Branches

ON April 22 the UNIVERSITY OF AKRON STUDENT BRANCH met jointly with Akron-Canton Section. George Marinoff, a junior, read his paper on "Economic Aspects of Our Expendable Power Resources." This paper won second prize at the student regional meeting held at the University of Pittsburgh on April 16. Dean Fred E. Ayer of the engineering college made an address on "The Engineering College and the War."

The UNIVERSITY OF ARIZONA STUDENT BRANCH held its last meeting of the season on April 19, Reece J. Dunaway reported on this Branch's participation in the annual student convention at New Mexico State College of Agriculture and Mechanic Arts. Fred Fiedler was named the outstanding senior and his name is to be engraved on the A.S.M.E. senior plaque, while a certificate of award is to be presented to Reece Dunaway. New officers were elected.

Aircraft Diesels

The A.S.M.E. Student Branch of the UNIVERSITY OF ARKANSAS met on April 6 and plans were made for a picnic at Lake Wedington on April 18. B. Owen spoke on "Aircraft Diesels" and stated that the first Diesel was made in 1897, and the first Diesel suitable for aircraft use was made in 1910.

BROOKLYN POLYTECHNIC INSTITUTE held its meeting on May 4. Plans were discussed for a picnic or a smoker and a committee was appointed to take care of arrangements. After the meeting the members enjoyed luncheon.

On April 4, CALIFORNIA INSTITUTE OF TECHNOLOGY STUDENT BRANCH inspected the site of the Southern Co-Operative Wind Tunnel.

This field trip was held jointly with the A.S.C.E.

"Life" and "Esquire" Brighten California Library

On March 3 the UNIVERSITY OF CALIFORNIA STUDENT BRANCH held its second spring semester meeting. Mr. Ela spoke on some of the processes used in the chemical-engineering field. Dr. R. G. Folsom, the honorary chairman, concluded the meeting with a talk on the purposes of the A.S.M.E. and the advantages of membership. At a meeting on March 31 this group decided to donate a subscription to *Life* and *Esquire* to the engineers' library. The three members submitting papers for the Stanford meeting on April 17 presented their respective subjects: Dave Kline, on "Production Inspection;" Allen Bryant, on "Philosophy of Engineering;" Milton Kodmur, on "Heating and Cooling by Panels."

On April 8 members of the CASE SCHOOL OF APPLIED SCIENCE BRANCH were the guests of the Cleveland Section of the A.S.M.E. Speeches were made by prominent engineers. Entertainment was provided by a magician and a ventriloquist.

On March 22 the UNIVERSITY OF CINCINNATI STUDENT BRANCH enjoyed a dinner meeting. Mr. Bernard Niemeier, president of the Pi Tau Sigma, made public presentation of large wooden PTS keys to the graduating seniors. Prof. Isay Balinkin of the physics department spoke on "Hand Chrome plating" a technique whereby dies and punches are chrome-plated for increasing the resistance to wear.

COOPER UNION STUDENT BRANCH met on April 27 to hear the delivery of the first of a series of student papers. Howard Goldberger, a senior at the Institute, spoke on "Radiant Heating."

"The Mikado" Enjoyed by Detroit

The UNIVERSITY OF DETROIT STUDENT BRANCH has had several meetings this year. On January 14 the group digressed from the usual technical type of meeting and heard Gilbert and Sullivan's "The Mikado." The entire operetta was covered, the story was related by Father Quinn, and the music was provided by records played in the music room. On February 11 two short movies were shown at an afternoon meeting. A discussion was given on opportunities within reach of the student members by writing a paper for the A.S.M.E. Convention at the Michigan State College on May 8. On March 11 this Branch heard H. Archer from The Detroit Edison Company speak on "Industrial Heating."

Blackout no Obstacle to Speaker at Drexel

The STUDENT BRANCH OF DREXEL INSTITUTE OF TECHNOLOGY held a joint meeting with the Villanova Student Branch as guest. There were seventy present. T. Pomeroy, acting chairman, introduced Lieutenant Harold Allen, U.S.N., of the Philadelphia Naval Aircraft Factory. Lieutenant Allen has had much experience in the design, construction, and testing of airplanes; having taught in the leading engineering colleges of the country. He spoke on "Structural Design in Aircraft." In the middle of his talk an unannounced test blackout took place. He continued his speech holding the interest of his audience.

At a meeting on April 9 the UNIVERSITY OF FLORIDA BRANCH awarded a biography of a prominent engineer and a certificate of award to chairman H. N. Ellis, chosen as the A.S.M.E. student rendering the most service to the organization. This Branch met on April 23 at which three talks were given by student members. The most interesting talk was on the Sperry Company's automatic gyroscopic pilot.

A joint meeting of the A.S.M.E. Student BRANCH OF THE UNIVERSITY OF ILLINOIS, A.S.C.E., A.I.E.E., and the physics department was held on March 18. Prof. Max A. Faucett, assistant professor of electrical engineering, was toastmaster. Dr. E. U. Condon, head of the research department of Westinghouse Electric & Manufacturing Co., spoke on "Micro-Wave Guides." On April 5 this group met to select a representative of the University Branch for the regional meeting at Northwestern University of April 12 and 13. Paul Salerno presented his paper on "Water Ejector Pump" and W. Gailus spoke on "Fatigue Properties of a Paper Laminate Used in the Aircraft Industry." The decision was given to Gailus. This Branch met again on April 28. P. R. Nolan gave a talk on "Woodward Governors." After Mr. Nolan's discussion a U. S. Navy film was shown depicting the applications of governors on a submarine.

IOWA STATE COLLEGE BRANCH held its meeting on March 31 at which Ed Otto and R. C. Smith were appointed chairman of Vieshea Open House and Booth committees, respectively. Harrison Bahr was elected treasurer. Plans for a picnic to be held during the present quarter were discussed.

Streamlined Trains Subject at Kentucky

The UNIVERSITY OF KENTUCKY BRANCH held its meeting on April 16 at which Professor Jett announced that Prof. Roscoe W. Morton of the University of Tennessee will speak on "Streamlined Trains" on May 30. Prof. Perry West gave an encouraging talk with reference to present world conditions, urging students to return and finish their studies after the war. A film was shown on "The Construction of a Light Airplane."

At the Student Branch meeting held on April 1 the UNIVERSITY OF MARYLAND group heard H. H. Snelling, patent lawyer from Washington, D. C., give a talk on "Explosions" after which he answered students' questions on modern ammunition.

Wind Turbines Subject at M.I.T.

The M.I.T. STUDENT BRANCH at its meeting on March 18 heard Professor Wilbur, of the department of civil engineering and chief engineer of the Smith-Putnam wind-turbines project in Vermont, speak on that subject. This project is still in its experimental stage but is considered to be successful enough so that sponsors find it worth while to continue investments in the experiment. On April 8 this Branch met and Professor Morris of the geology department of the Institute spoke on "Plans for Postwar Reconstruction." All R.O.T.C. students have returned to the school for the completion of this term. Plans will be made for at least one more meeting.

The UNIVERSITY OF MINNESOTA STUDENT BRANCH met on April 21 for their first meeting and a "fun" night. After a short business meeting the members enjoyed billiards and recreation in the rumpus room.

On April 1 the MONTANA STATE COLLEGE BRANCH heard Hugh Roberts speak on "Adventures of Motor-Torpedo Boats." Kent O'Kelly spoke on "Photography Used on Blueprinting." On April 8 Howard Wagar spoke on "Helicopters," and Louis Marantette on "Engineering in Montana." On April 15 John Medlin, senior, reported on "Power Line Construction." At the April 22 meeting new officers were elected and then Cecil Johnson spoke on "Ghost Towns," describing past engineering and the operation of mines in the ghost towns. This Branch met again on April 29. After a business meeting Ed Galligan spoke on the development and design of the variable-pitch airplane propeller. He also showed that the invention of the variable-pitch propeller with all its advantages—the past's dream for the future—is one illustration of the vast opportunity for the mechanical engineers in aviation engineering.

On April 8 the CITY COLLEGE OF NEW YORK STUDENT BRANCH listened to a lecture by W. Hughes White of the Faitoute Iron Company on "Tool Steel." This lecture was well illustrated and the speaker stated that although there was seemingly endless variety of special steel for the purpose of cutting other metals, almost all of this work could be done with about fifty steels, and that a large percentage of this work could be done with far fewer than fifty analyses.

Professor Rautenstrauch at North Carolina

On February 23 the NORTH CAROLINA STATE COLLEGE BRANCH held a regular business meeting at which new officers were elected. On April 13 this Branch met to elect new officers again as three of those previously elected ones were called to active service. Professor Walter Rautenstrauch, Mem. A.S.M.E., head of the industrial-engineering department at Columbia University, told of some experiences as a consulting engineer. On April 27 this Student Branch met and Prof. F. C. Bragg, Mem. A.S.M.E., presented "The Autobiography of an Engineer" to Richard Jarrell, who is the president of this Branch, as the most outstanding A.S.M.E. student. Bob Pomeranz gave a talk on "Production Aids in a Machine Shop."

The NORTH DAKOTA STATE UNIVERSITY STUDENT BRANCH met on April 16 to elect new officers: Russel Odegard, president; Harold Christensen, vice-president; Louis Blazek, secretary; and Leland Aplin, treasurer.

The OHIO STATE UNIVERSITY BRANCH held its first spring-quarter meeting on April 2. Prof. S. M. Marco introduced the new system of attendance and explained the functioning of student and affiliate Branches of A.S.M.E. to the incoming junior class in mechanical engineering. This Branch held its second spring-quarter meeting on April 9 jointly with the S.A.E. Professor Marco, honorary chairman, discussed the annual local A.S.M.E. speaking contest. The number of entries were limited to eight. A film was shown on "Curtiss-Wright Answers the Call for Quality."

On April 21 the UNIVERSITY OF NEBRASKA STUDENT BRANCH was entertained by Norman Kuska, who spoke on "The Construction of the Kingsley Dam," located in western Nebraska. Mr. Kuska, who worked on this project for three and a half years, was thus able to present a very interesting program.

SOME RICE INSTITUTE A.S.M.E. STUDENT MEMBERS

(*Left to right, first row:* M. M. Fitch, Robert Whittlinger, W. H. Vernor, Jr., secretary-treasurer; H. E. del Castillo, C. C. Camp, Eugene Stone, Bill Sheehan, A. Moskowitz, Morton King; *second row:* George Neal, Bill Rice, K. Sandow, C. P. Sumners, Tracy Park; *third row:* Joe Nelson, Alvin Nuckolls, Morris Wright, R. D. Bonner, John Silvey, J. K. Jones, K. G. Klindworth, Ken Wood, vice-chairman, George Williams, Eugene Heyck, R. E. Howard, C. R. Horn, Andres de la Garza, George Flint, J. B. T. Downs, honorary chairman, E. Badger; *last row:* Stephen Buckley, George Morris, Bob Cook, M. F. Clegg, J. E. Mims, chairman, Jack Word, and H. E. Staph.)

The NEWARK COLLEGE OF ENGINEERING STUDENT BRANCH held a meeting on April 19. The speaker, Mr. Kasschau of the Wright Aeronautical Corporation in Paterson, New Jersey, spoke on "The Wright Cyclone Engine —Its Development, Test, and Production." He pointed out that the 14-cylinder 2600-B develops 1700 hp at a take-off speed of 2800 rpm. The displacement of this model is 2600 cu in. Two reels of sound motion pictures supplemented Mr. Kasschau's talk. One reel portrayed the production and inspection of the Wright engine and the other the use of Wright engines in service and combustion of fuel within the cylinders.

Competition Papers at New Mexico

On March 9 the UNIVERSITY OF NEW MEXICO BRANCH held its meeting and heard a presentation of papers for the district A.S.M.E. competition. Edward Rightley gave a paper on "Lubricating Oils in Internal-Combustion Engines," and Robert Tatge discussed "Aircraft Welding." On March 23 this group met and Arthur Williams read a paper on "Physical Properties and Uses of Thiokol." On March 30, Bob Simpers was elected the outstanding senior active in A.S.M.E. affairs. Robert Hutchinson read a paper on "Plywood in Aircraft Structures." The two students awarded prizes for papers were, first prize, Edward Rightley, second prize, Arthur Williams.

The N.Y.U. COLLEGE OF ENGINEERING BRANCH met on March 16 and held elections for the next semester. New officers are C. Edward Kovacs, chairman, Gerald Selvin, vice-chairman, Isaiah Eisen, secretary, and Paul Hansell, treasurer. An oral report contest was held at an evening smoker on March 31. Ray Vackss received first prize for his speech on "Steam-Power-Plant Cycles;" second prize was awarded to Gerald Selvin, whose topic was "Application of Plastics;" and third prize to Herman Simon, who described "Water Purification."

The OKLAHOMA A.&M. BRANCH met on April 12 to hear Nathan Shapiro speak on "The Combustion-Gas Turbine" and Morris Weingarten on "Ignition Lag in Compression-Ignition Engines." A film on "Steel for Our Armed Forces" was shown.

HERMAN J. BRENNEKE RECEIVES LINCOLN SCHOLARSHIPS

(Recipient of first award in Lincoln Foundation Engineering Undergraduate Award and Scholarship Program, Herman J. Brenneke, department of mechanical engineering, New York University, New York, N. Y., received $1000 and had four scholarships of $250 each presented in his name to his university's department of mechanical engineering.)

PRATT INSTITUTE held a joint meeting with the A.I.C.E. and the A.I.E.E. on April 14 at which about 100 students were present. A sound film depicting the construction of the new Los Angeles water system was shown under the auspices of the Barrett Company. The Branch was proud to announce that Joseph Mazzola, a senior Branch member, had won the second prize at the Spring Student Branch convention held at C.C.N.Y., Saturday, April 17. The subject of Mr. Mazzola's paper was "A Proposed Design for an Explosion Gas Turbine."

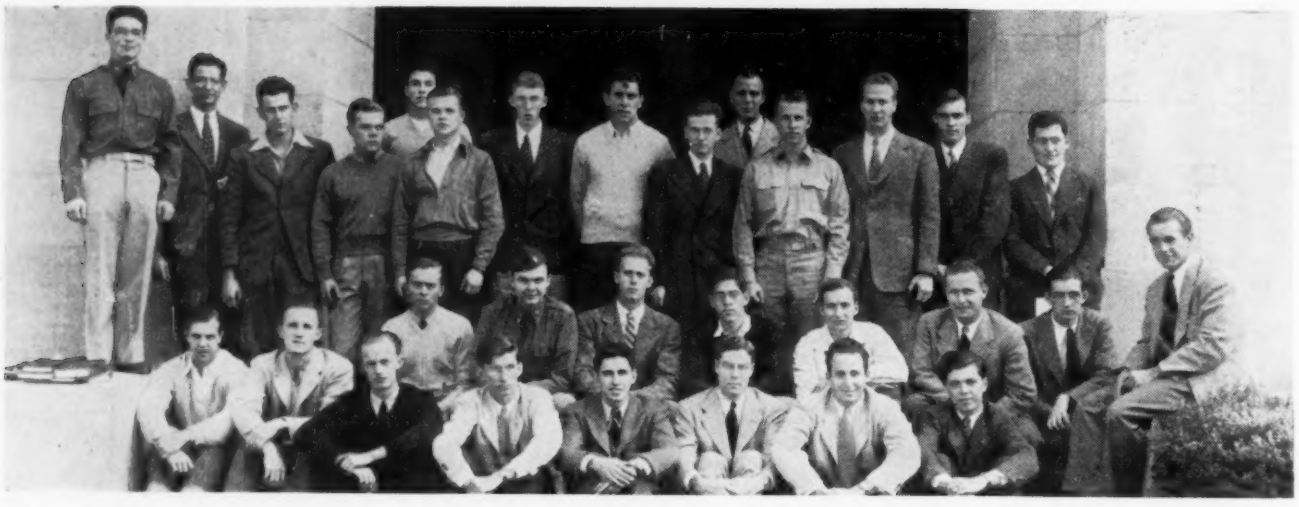
The RICE INSTITUTE STUDENT BRANCH met on March 10 when L. C. Mudd, of the Shell PipelineCompany; gavea talk on "Corrosion—Its Causes and Prevention." On March 17 the Rice membership saw an interesting film on "Commercial Production of Wrought Iron and Its Associated Products," made at the Byers Wrought Iron Company plant. This Branch met on March 24 to hear a lecture given by a member of the Studebaker Corporation staff on the Wright Cyclone-9 aircraft engine used to power the Flying Fortress. On the evening of April 2 this group held a smoker for departing senior members of the Branch.

This Branch held its meeting on April 15 to elect officers. Robert Wittlinger was named to receive the annual certificate of award in recognition of his outstanding work as chairman for the first semester of the current academic year. The annual biography award was given Kenneth Campbell for his tireless effort as secretary-treasurer for the first semester.

Powder Metallurgy at Rutgers

On Feb. 12 RUTGERS UNIVERSITY STUDENT BRANCH held a meeting at which Prof. J. B. Cejka, honorary chairman, spoke on the advantages of being an A.S.M.E. member. On March 10 this group met to elect new officers: Wm. Griffin, vice-chairman, and John H. Gaston, treasurer, to replace Edwin L. Minch and James F. Wright who were called to the armed forces. On April 14, the Branch met with the Plainfield Section of the Student A.S.M.E., and Prof. Joseph D. Stetkewicz of Rutgers spoke on "Powder Metallurgy." After the talk, the students entertained the speaker and guests with a song fest and doughnut party. On April 19 six student members of this Branch attended the A.S.M.E. Student convention at Drexel.

The UNIVERSITY OF SANTA CLARA STUDENT BRANCH held its banquet on April 14. Next



STANFORD UNIVERSITY A.S.M.E. STUDENT MEMBERS

year's officers were elected and awards were presented to the two most active A.S.M.E. members of the past year. A book entitled "Autobiography of an Engineer" was presented to the chairman, Paul Steffan, and a plaque was voted for secretary William Houle. Joe Lepetich presented a paper on "Solar Engines on a Large Scale in the Future."

Student Papers Presented at Southern Methodist

The SOUTHERN METHODIST UNIVERSITY BRANCH held a joint meeting with the section members of North Texas to deliver student papers. The first prize was awarded Hugh Campbell for his paper on "Surface Hardening of Carbon Steels by Induction Heating." Second prize went to Gordon King for his paper on "Armament of Modern Aircraft." Other papers presented were: "Butane Burning Engine," by Milton Smith; "Design for Molding Plastics," by Lloyd Cone; "Supercharging Diesels," by Gerald Kraus; and "Comparison of In-Line and Radial Diesel Aircraft and Engines," by Carl Ivey.

On April 7 STANFORD UNIVERSITY STUDENT BRANCH held an informal meeting with Cedric Ferguson as chairman. Morris P. Taylor, assistant chief engineer of the Southern Pacific Railway Company, Mem. A.S.M.E., gave a talk on "Replacement of Steam Locomotives With Diesel-Electric Locomotives for Use as Switching Engines." He also discussed designs and construction advantages.

The UNIVERSITY OF TEXAS BRANCH on April 5 heard Mr. Perkey speak on the subject of the "Curtiss-Wright Engine" built by Studebaker. His lecture included the arguments for and against air-cooled and liquid-cooled engines, the problems encountered in keeping weight ratio down, the process of manufacture of some of the vital parts, and the relation of the various parts of the engine to one another. Chairman Maurer announced that the A.S.M.E. won a baseball game on April 5.

TUFTS COLLEGE STUDENT BRANCH met on March 11 and the membership committee expected pledges of at least 30 new members by the first of April. Two films were shown, the first, by Wright Aircraft Corporation; the second, by the Dodge Division of the Chrysler Corporation. Both pictures presented a very fine insight into mass-production methods of these large corporations. On April 13, this Branch enjoyed a film on "Die Casting" from the New Jersey Zinc Corporation. Mr. David Fisher announced that there would be no spring meeting this year due to the war. He also announced that a certificate of appreciation would be awarded to past chairman Winchel.

Queen of the "Paul and Sophie" Dance

TULANE UNIVERSITY STUDENT BRANCH on April 1 selected Miss Lana Hummel as the A.S.M.E. queen at the annual Paul and Sophie dance on April 17. George Menefee, chief machinist mate, U.S.N., who is in charge of the machine shop at the Algiers Naval Base, and a former Tulane student, gave a talk on "Diesel Engines." At its meeting on April 5, John Luis Martinez was awarded an "Autobiography of William Emmet" for his talk on "Elements of Airfoil Design." The certificate of merit was awarded Ben Flake for his excellent work as treasurer of this organization.

On April 8 WASHINGTON UNIVERSITY BRANCH heard Mr. Gene Anthony give an interesting talk on "Photoelasticity." At its meeting on April 15 a preview student presentation of papers for the convention was heard. Harvey Franzel and Gene Pottiz were the speakers.

The WYOMING UNIVERSITY STUDENT BRANCH of A.S.M.E. accompanied by C. E. Anderson, chairman of the mechanical-engineering department, Mem. A.S.M.E., and H. Fry, assistant professor, motored to Fort Collins, Colorado, to attend the eleventh annual conference of the Rocky Mountain Student Branches. Short talks were given by Dr. Leonard Loeb, special guest; Frank H. Prouty, Mem. A.S.M.E., representing President Coes, and Prof. Herbert Kuenzel, Mem. A.S.M.E., representing the Committee on Relations With Colleges. James E. "Red" Young of Wyoming Student Branch won second place with his paper on "Experiences at Pratt and Whitney."

YALE UNIVERSITY STUDENT BRANCH met on April 13 and heard the following technical papers presented by student members: "Glass for Precision Gages," by J. F. Baxter; "Plastic Plywood Airplanes," by J. P. Wilke; "Aircraft Instruments," by J. Magin; "Brewing, From Ancient to Modern Science," by R. J. Vollrath, and "Helicopters," by H. D. Williams. On April 20, this University's student branches of the A.S.M.E., A.S.C.E., and A.I.E.E., held a joint meeting. Philip Babb of McKensey & Company, management consultants, New York, N. Y., spoke on the conversion of a shirt-and-tie factory into a gas-mask manufacturing plant. Mr. Babb brought out the problems and difficulties encountered, the solutions, and the progress made by the plant after conversion.

Pi Tau Sigma Installed at University of Detroit

THE Mechanical Engineering Department of the University of Detroit has recently been granted a chapter of Pi Tau Sigma, the National Honorary Mechanical Engineering Fraternity. This fraternity, founded in 1915, has 32 chapters in such Colleges of Engineering as Illinois, Wisconsin, Purdue, Minnesota, Penn State, and Rensselaer. While the University of Detroit merits the membership because of its standing among engineering colleges, the University considers it an honor to be granted a chapter. Mechanical engineering students now have the opportunity to earn membership in Pi Tau Sigma fraternity and, upon graduation, can take their rightful places among the members who are graduates of other schools.

Pi Tau Sigma members are chosen on a basis of sound engineering ability, scholarship, personality, and probable future success in their chosen field of mechanical engineering. There are three grades of membership: honorary, graduate, and active.

The installation of the University of Detroit Chapter, known as Pi Eta, took place on May 15. The installing officer was Prof. E. S. Gray, head of the mechanical engineering department at the University of Missouri and National Council Secretary of Pi Tau Sigma. The preliminary work of obtaining a chapter was carried on through him and through Prof. H. E. Degler, head of the mechanical engineering department at the University of Texas, National Council President, who visited the University on this matter about six weeks ago.

The following charter members will be initiated at the installation of the University of Detroit, Pi Eta Chapter: Dean C. J. Freund, E. A. Bayer, J. Brown, R. B. Doyle, J. L. Gilmour, G. L. Kasparian, J. Z. Lance, A. C. Miknis, R. J. Offer, J. J. Roethel, J. J. Sazynski, J. J. Uicker, and F. P. Van Dame.

(*A.S.M.E. News continued on page 464*)

NO. 6 OF A SERIES

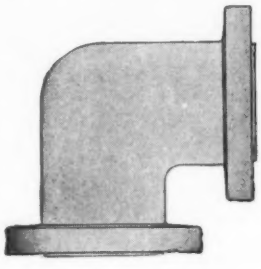
HOW TUBE-TURN WELDING FITTINGS BENEFIT WAR INDUSTRY

The FIRST WELDING FITTINGS 1ST AND STILL THE BEST

Weight saved* with Tube-Turn Welding Fittings aids war industry—by economizing steel, speeding pipe erection, conserving supports, reducing shipping weight.

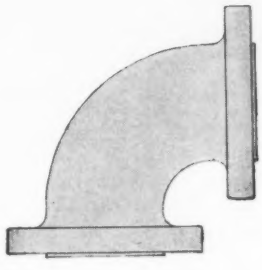
**Tube-Turn fittings in comparison below are 6", Schedule 80. Other fittings are 6", 600 lb. class.*

FORGED FLANGED ELBOW



450 lbs.

CAST STEEL FLANGED ELBOW

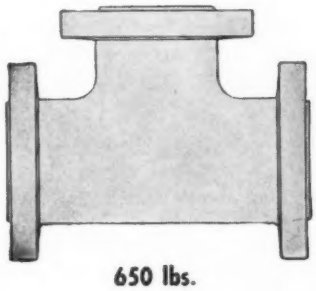


250 lbs.

TUBE-TURN WELDING ELBOW

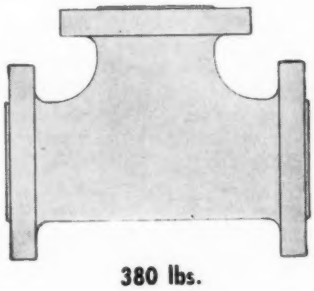
33 1/2 lbs.

FORGED FLANGED TEE



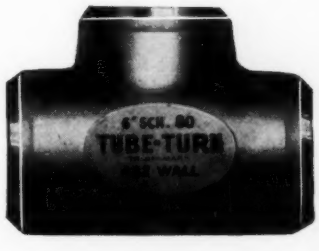
650 lbs.

CAST STEEL FLANGED TEE



380 lbs.

TUBE-TURN WELDING TEE



80 lbs.

THE examples illustrated above demonstrate the tremendous differences in weight between Tube-Turn welding fittings and other types of steel fittings. These comparisons are for 6" size (see note above), and other sizes are more or less proportionate.

Weight saving *always* has been an important reason for specifying Tube-Turn welding fittings. But today's war production needs stress additional advantages of this feature. It saves steel—because less of this strategic metal is required in making Tube-Turn fittings. Piping systems welded with Tube-Turn fittings are *lighter* and *streamlined*—which speeds erection, saves space, and simplifies structural problems. Remember these timely points when you buy or specify fittings for oil, gas, power, chemical, heating, air, refrigeration and marine piping today!

OTHER WAYS TUBE-TURN FITTINGS HELP WAR PRODUCTION:

SPEED INSTALLATION: Less time needed for aligning thanks to true circularity and uniform walls. Only simple butt welds required, easy even for novice welders. Whole section can be preassembled on the ground.

SAVES SPACE: Tube-Turn fittings permit streamlined, compact layouts and sharp angles—neater, more efficient piping.

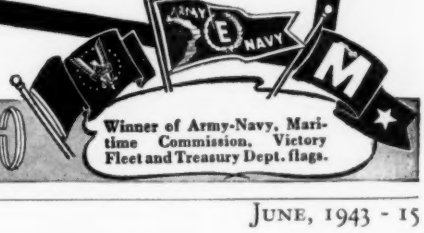
REDUCES MAINTENANCE: No gaskets to replace, no nuts or bolts to tighten. Maintenance practically eliminated. Relieves men for other duties.

AVOID SHUT-DOWNS: Practically no danger of shut-downs due to connection failures as welding with Tube-Turn fittings *eliminates* the chances of leakage.

INCREASE SAFETY: Exclusive manufacturing process gives greatest possible strength in fittings, full freedom from leakage, and longer life in piping systems.

TUBE-TURN
TRADE MARK
Welding Fittings and Flanges

TUBE TURNS (INC.) LOUISVILLE, KY. ● *Branch offices:* New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Dayton, Washington, D. C., Houston, Los Angeles. ● *Distributors in principal cities.*



Winner of Army-Navy, Maritime Commission, Victory Fleet and Treasury Dept. flags.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

New York	Boston, Mass.	Chicago	Detroit	San Francisco
8 West 40th St.	4 Park St.	211 West Wacker Drive	100 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

PROMINENT WELDING ENGINEER, consultant, author, and educator; Stevens and R.P.I. graduate; seeks position with essential industry, engineering group, or educational institution. To improve existing welding methods; develop new procedures; convert to welded design; supervise production; estimate; set up training programs for engineers and operators. Me-801.

FACTORY MANAGER OR CHIEF ENGINEER available for work anywhere; 47 and 3-A. Broad manufacturing and design experience—instrument to machine tools—in small and large companies. Has personnel and sales experience. Me-803.

POSITIONS AVAILABLE

INSTRUCTOR for department of mechanical engineering. Texas. W-1981C.

PLANT SUPERINTENDENT. Must have thorough technical training, mechanical experience; be capable of handling routing, planning, and estimating of machine-tool parts. Write, giving complete data, and indicate salary. Connecticut. W-1982. Reopened.

DESIGN ENGINEER, graduate mechanical, thoroughly practical, experienced in creative mechanical development work with executive ability and unusual inventiveness. Will head engineering department. Permanent with exceptional opportunity for American citizen. Salary open but substantial. Indiana. W-2131-C.

DESIGN AND DEVELOPMENT ENGINEER, graduate mechanical, to develop product for postwar manufacture. Must be of inventive frame of mind, be interested in such work. Salary, $5000 a year. New York, N. Y. W-2132.

PRODUCTION CONTROL ENGINEERS experienced in machine-shop operation, particularly screw machines. Permanent. Salary, $5000–$6000 a year. Northern New Jersey. W-2133.

DESIGNER-DRAFTSMAN, graduate mechanical engineer, for design on special tape machinery. Background in paper-machine manufacturing desirable. Salary, $4320 a year. Permanent. Northern New Jersey. W-2141.

ENGINEER, either graduate mechanical or electrical. Will work in engineering department of large manufacturing and service organization. Work will involve design, development, and service of equipment; test of maintenance of engineering status of product. Permanent. Should be reasonably draft-exempt. Salary, about $4200 a year. Northern New Jersey. W-2153.

ELECTRICAL ENGINEER who has had a good background in communications field and who is qualified to carry on work in electronics research department. Should be reasonably draft-exempt. Salary, about $5000 a year. Northern New Jersey. W-2157.

TOOL ENGINEER with good background in design, specification, and inspection of small alloy-steel tools, such as punches, dies, and cutters. Similar experience on gages would be acceptable as an alternative. Salary dependent upon qualifications; about $6000–$7500 a year. Maryland. W-2158.

MECHANICAL ENGINEER who has had considerable experience in glass forming or fabrication field. Must have good knowledge of problems of glass manufacturing as well as machinery used in manufacturing process. Salary open. Pennsylvania. W-2176.

METAL LAYOUT MEN with experience in aircraft metal layout field. Salary, to $7200 a year. Pennsylvania. W-2186.

MECHANICAL ENGINEER experienced in the design, improvement of, and speed up of gadgets for large machine-tool operations. Salary, $5400 a year. Pennsylvania. W-2202.

SHOP SUPERINTENDENT, experienced. Should be graduate engineer with intimate, firsthand knowledge of machine-shop practice and management. Will have complete charge of large machine shop, pattern shop, and fabricating plant. Salary open. Ohio. W-2213-D.

MECHANICAL DESIGNERS who have had considerable experience in design of heavy machinery of close-precision type. Work will be on high-priority defense project. Salary open. Duration about one year. New York metropolitan Area. W-2221.

ENGINEERS. (*a*) Mechanical engineers, executives, capable of running large federal manufacturing project. Salary, $4600–$6500 a year. (*b*) Industrial engineers with experience on production and control for metal-manufacturing plant. Government work. Salary, $4600–$5600 a year. New Jersey. W-2223.

INSTRUCTOR in mechanical engineering. Will start July 1. Pennsylvania. W-2224.

OFFICE ENGINEER, mechanical, not necessarily graduate. Will be in charge of all changes in design from War Department on prime contracts. Company's staff will do drafting. Applicant will be required to check and see that changes get into production departments. Will carry on all engineering correspondence. Salary open. Rhode Island. W-2225.

MECHANICAL ENGINEER with some experience in mechanical end of design of cranes and ore bridges, and who has been exposed to difficult computation problems which such designs require. Pennsylvania. W-2227.

PLANT SUPERINTENDENT for 200-man shop.

(*A.S.M.E. News continued on page 466*)

[1]All men listed hold some form of A.S.M.E. membership.

Official U. S. Navy Photograph

AMERICAN AIRMEN IN ICELAND AT THEIR CAMP AT A FLEET AIR BASE THERE

(Pronounce the camp's name slowly—it's good advice.)

AN IRON HAND . . . *in a Velvet Glove*

12 millionths of an inch is tolerance limit for work on this Ultra-Lap Machine that produces optically flat metal surfaces. A compactly designed Morse Roller Chain drives the front spindle—delivering a power flow that remains necessarily constant and "precise"—because there's no possibility of slip, regardless of load.

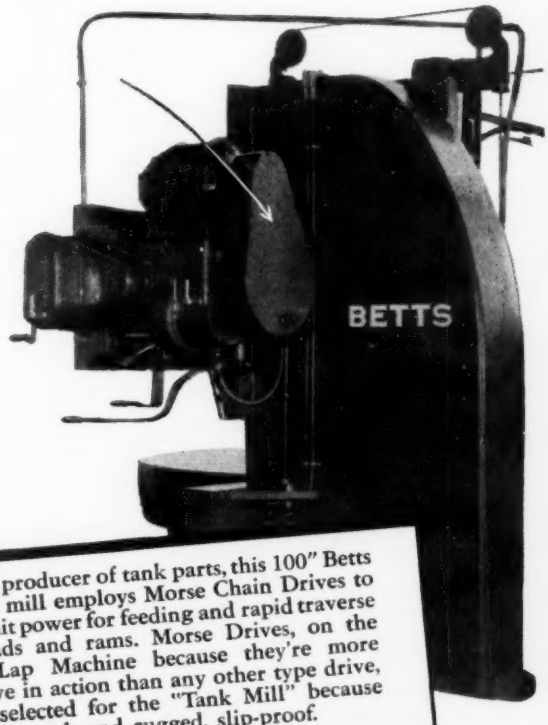
THE LINKS—"metal fingers"—of Morse Chain Drives are tough and sure, slip-proof. That's why Morse Chain Drives are selected for jobs where power must be transmitted with an "iron hand"—firm, steady and dependable—capable of handling even steel mill roll drives of 5,000 h.p. and upward, at high speeds, at practically 100% efficiency—without power losses due to slippage that might occur with other type drives.

BY CONTRAST . . .

Morse Chain Drives, because they operate on the principle of "Teeth Not Tension" and perform like an "iron hand in a velvet glove", are selected for precision work requiring amazingly close tolerances—because they deliver a flow of power that is constant and uniform, assuring a uniformity of produced parts that cannot be approached where driving devices slip or falter even slightly.

* * *

If you are engaged in post-war planning, looking ahead—then look to Morse for equipment that will help your machines to better, speedier production, and lowered production costs. Right now, your nearby Morse representative will be glad to help you solve any power transmission problems relative to essential war-time production.



A mass producer of tank parts, this 100" Betts boring mill employs Morse Chain Drives to transmit power for feeding and rapid traverse to heads and rams. Morse Drives, on the Ultra-Lap Machine because they're more positive in action than any other type drive, were selected for the "Tank Mill" because they're tough and rugged, slip-proof.

SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS CLUTCHES

MORSE *positive* DRIVES

MORSE CHAIN COMPANY ITHACA, N. Y. DETROIT, MICH. DIVISION BORG-WARNER CORP.

Must be thoroughly familiar with cutting tools and be able to plan their manufacture. Must be able to efficiently schedule routing of products through shop and be able to step up production. Company also is interested in a Chief Inspector. Salary open. Middle West. W-2229-CD.

ENGINEER capable and experienced in coordinating mechanical work in field. The mechanical work consists of installation of utilities, sewers, water, steam, heating, and electrical services; also water, sewage disposal, heating, and electrical systems. Must be able to anticipate requirements of various subcontractors and obtain required information. Maryland. W-2242.

SALES AND FIELD ENGINEER, graduate mechanical preferred, for sales work for steam and power-plant specialties, safety and control valves, etc. Salary plus expenses. Permanent. New Jersey. W-2246.

ENGINEERS. (*a*) Design engineers, over 45, to work on new equipment and also redesign present products. Should be graduate electrical engineers. Salary, $7500–$10,000 a year. (*b*) Draftswomen. Ohio. W-2253-D.

DESIGNER, mechanical, who has had considerable experience in boiler design. Should be familiar with boiler codes and standard practice. Salary, $4000–$4800 a year. Washington, D. C. W-2263.

DESIGN AND DEVELOPMENT ENGINEER who has had well-rounded experience in machine design. Prefer man who has had some experience on hemp- or manila-fiber processing machinery, although an engineer with experience on similarly constructed machines will qualify. Salary, $4000–$4800 a year. Washington, D. C., or Chicago. W-2264.

MECHANICAL ENGINEER, master's degree, broad practical shop and technical skill, medium and heavy machinery and machine tools, high-production precision machinery. Mathematical stress analysis, research, and development. Good executive experience. Me-802.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after June 25, 1943, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ARGUST, FRANK F. (LIEUT.), New York, N. Y.

BAINTON, W. B., Providence, R. I.
BAKER, P. H., Breward, N. C.
BASELT, WALTER H., Chicago, Ill.
BRECHT, W. ALLEN, Wilkinsburg, Pa.
CHAMBERLIN, JOHN W., Milwaukee, Wis.
CHAPPELL, HENRY D., Detroit, Mich.
CHURCHILL, W. R., JR., Huntsville, Ala.
COFFIN, C. W., Dedham, Mass.
COLLINS, A. R., Chicago, Ill.
DE LEAR, NICHOLAS L., Teaneck, N. J.
DOBBS, JOHN F., Watertown, N. Y.
DRUMPELMANN, C. T., Niagara Falls, N. Y.
ERDOSS, K. B., Easton, Pa.
ERICKSON, HARRY A., Chicago, Ill.
ERON, L. T., Wisconsin Rapids, Wis.
FERGUSON, WILLIAM B., Quebec, Canada (Rt)
HAINER, FREDK. W., Milwaukee, Wis.
HAINES, E. M., New York, N. Y.
HARLEY, JAMES A., Saginaw, Mich.
HATCH, CHARLES H., New York, N. Y.
HEPBURN, N. C., Washington, D. C.
HESS, R. G., Watertown, N. Y.
HILL, W. E., New York, N. Y.
HIRT, JOHN H., Palo Alto, Calif.
HOGAN, W. E., Bridgeport, Conn. (Rt)
HOOVER, WALTER M., Las Vegas, Nevada
KARGE, F. W., Los Angeles, Calif.
KEARNEY, JOSEPH D., Seattle, Wash.
KELEHER, JOHN E., Yonkers, N. Y.
KICE, MURRAY S., Birmingham, Mich.
KINZIE, PHILLIP A., Denver, Colo.
LADERACH, O. W., Peterborough, Ont., Can.
LANG, HERMAN A., Ithaca, N. Y.
MADEY, EUGENE, Baltimore, Md.
MAYNARD, HAROLD B., Wilkinsburg, Pa.
MCLAIN, W. R., Huntsville, Ala.
MOORE, HARRY F., Elizabeth, N. J.
MUNDEL, MARVIN E., W. Lafayette, Ind. (Re)
NELSON, LORRAINE R., Keokuk, Iowa
NEWBEGIN, JOHN L., Harrison, N. J.
PAFENBACH, C. H., Toledo, Ohio
PERRY, GERALD I. H., Elgin, Ill.
PFEIFFER, OLIN S., Alliance, Ohio
RADAMAKER, G. L. (LIEUT.), Chicago, Ill.
SAXE, J. B., Cranford, N. J.
SCHMID, CARL G., Indianapolis, Ind.
SCOTT, ROBERT J., Omaha, Neb.
SHANNON, R. H., Philadelphia, Pa.
SHOWLER, ALFRED J., Erie, Pa.
SKILLMAN, EDW., Wichita, Kans. (Rt)
STURM, FRED W., Irvington, N. J.
THORESEN, R. S., Riverside, Conn.
TURK, F. B., New York, N. Y.
UNDERBERG, SAMUEL, Brooklyn, N. Y.
WEDNER, BENJAMIN M., Pittsburgh, Pa.
WHITACRE, V. L., Englewood, N. J.
WIGGENHORN, R. H., Dayton, Ohio
WINSLOW, SETH L., Chicago, Ill.

CHANGE OF GRADING

Transfers to Member

ARCHIBALD, FRANCIS L., Medford, Mass.
BARKER, J. LAURANCE, JR., Charleston, W. Va.
KENT, N. W., Huntsville, Ala.
RUESS, MAX E., Milwaukee, Wis.
WEITZEL, WILLIAM F., Denver, Colo.

A.S.M.E. Calendar

of Coming Meetings

June 14–17, 1943
Semi-Annual Meeting
Los Angeles, Calif.

June 14–16, 1943
Oil and Gas Power Division
Baltimore, Md.

June 25–26, 1943
Applied Mechanics Division
Carnegie Institute of Technology
Pittsburgh, Pa.

October 28–29, 1943
Joint Meeting of A.S.M.E. Fuels and A.I.M.E. Coal Divisions
Pittsburgh, Pa.

November 29–December 3, 1943
A.S.M.E. Annual Meeting
New York, N. Y.

(*For coming meetings of other organizations see page 38 of the advertising section of this issue*)

Necrology

THE deaths of the following members have recently been reported to headquarters:

CHRISTOPH, JOSEPH, April 2, 1943*
JOHNSON, JOHN A., November 24, 1942
MCCARTY, RICHARD J., JR., March 22, 1943
SCHMELTZER, JOHN E., February 25, 1943
WERST, CHARLES W., March 22, 1943

* Died in line of duty.

A.S.M.E. Transactions for May, 1943

THE May, 1943, issue of the Transactions of the A.S.M.E. contains:

Antifriction-Bearing Developments for Aviation Engines, by Thomas Barish
Bevel Gears in Aircraft, by Allan H. Candee
Development and Performance of a Coal-Fired Unit Heater, by R. M. Rush
Improved Hydraulic Presses for Wartime Requirements, by J. H. Maude
Stress Analysis of Passenger-Car Trucks, by J. C. Travilia, Jr., and W. E. Burdick
Corrosion of Unstressed Specimens of Alloy Steel by Steam at Temperatures up to 1800 F, by G. A. Hawkins, H. L. Solberg, J. T. Agnew, and A. A. Potter
Effect of Deoxidation Practice on Creep Strength of Carbon-Molybdenum Steel at 850 and 1000 F, by R. F. Miller
Static Friction, by Walter Claypoole
Effects of Continued Heating on Mechanical Properties of Molded Phenolic Plastics, by T. S. Carswell, D. Telfair, and R. U. Haslanger
Drying of Textiles, by A. C. Walker
The Effect of Installation on the Coefficients of Venturi Meters, by W. S. Pardoe
Results of Tests on Volumeters for Liquid Hydrocarbons, by R. J. S. Pigott, E. E. Ambrosius, and E. W. Jacobson
Developments in the Measuring of Pulsating Flows With Inferential-Head Meters, by S. R. Beitler, E. J. Lindahl, and H. B. McNichols